THE
ELECTRICAL REVIEW.

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'ELECTRICAL REVIEW."

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ELECTRIC RAILWAY PROGRESS.

THE active interest which has been aroused amongst railway engineers—somewhat against their will, in some cases—in the application of electricity to railway working, is leading quickly to practical results. By a coincidence, in the present issue of the ELECTRICAL REVIEW, we chronicle the commencement of experimental running on the North-Eastern Railway, with direct current at 500 volts; the inauguration of experiments on the Nieder—Schöneweide Railway with single-phase A.C. 6,000-volt motors; and the attainment of a speed of 118 miles an hour on the Berlin—Zossen Railway, with three-phase currents at 10,000 volts. Further, we commence an account of the Valtellina Electric Railway in Italy, which is operated with three-phase currents at 20,000 volts, transformed to 3,000 volts for collection by the trains; this line has satisfactorily completed 12 months' commercial working, and considerable extensions are in progress.

While the direct current system, at 500 volts, may answer well for short and suburban lines, with many stoppages and dense traffic, it must be obvious to all who have given attention to the subject, that, as we have so often urged, the absolutely indispensable features of the long-distance main line railway of the future will be—very high pressure, and overhead conductors. Without these two essentials, which, moreover, are inseparably correlated, nothing can be done with main line working. The correctness of our views, which were put forward before any railway had been operated with high pressures on overhead lines, has been abundantly demonstrated, if proof be necessary, by the progress already made in this direction. Not only on the Continent, but even in the United States—where practice has hitherto been bound down rigidly, by standardisation and precedent, to "500 volts D.C." for all traction purposes—the facts have been recognised and acted upon.

The most prominent difficulty in the way of applying these principles has doubtless been the apparent necessity of utilising polyphase currents, implying the installation of two working conductors over each track, and the use of induction motors, in spite of their inability to run at various speeds. That these difficulties, inherent to polyphase working, are not insuperable has been plainly shown on the Valtellina Railway; but the remarkable progress which has been made of late in the evolution of a satisfactory single-phase motor leads to the belief that we shall not have to wait long before the problem is solved by this means. The system will then be of the simplest possible nature:—One conductor over each track, preferably fed direct from the generating station at, say, 10,000 volts; series-wound single-phase motors in motor-cars for passenger trains, and in locomotives for goods trains. So far as can be foreseen, having regard to the never-ceasing progress in electrical matters, this is the kind of railway equipment that we may look for in the future.

The experiments on Tyneside to which we have referred

fall, of course, into a different category—that of inter-urban service, with trains at very frequent intervals. Although a section of track only three miles long has been equipped as yet, this length sufficed to demonstrate the satisfactory working of the system; a speed of 45 miles an hour and an acceleration of 1·5 ft./second², were attained. In general, the equipment is similar to that of other electric railways in this country, the train consisting of two motor-cars with a trailer between, operated on the multiple-unit system. The local Press claims for this line the honour of being the first surface electric railway in this country; but this of course is not the case.

When is a Loss not a Loss?

Our analysis of the Islington electricity accounts, which appears under "Supply Station Accounts" to-day, will, we believe, be examined with great interest. As we mentioned several week ago, despite the fact that there is a deficit on the year's working, and no reserve fund, an attempt was made in certain local quarters to show that a large net profit had been earned. Now, how was this done? In no other way than by treating as profit the sum placed to sinking fund! It is also thus shown in the official summary of the profits and losses since the commencement of the undertaking. We do not expect municipal departments to possess very sensitive consciences, but this appears to us to be nothing short of a deliberate attempt to mislead, although it seems to have the approval of one of our contemporaries which last week mentioned "*£20,000 net profit*" as Islington's total achievement to date. For such manipulation one cannot hold the engineering staff responsible; but, whoever is to blame, it is not correct procedure. We are afraid that our periodical censuring of municipal juggling with figures has sometimes been regarded by borough engineers as a personal reflection upon themselves and their management. This has seldom been our intention. We, of course, understand that there are few engineers who are solely responsible for both the finance and engineering of an undertaking; indeed, the too common rule is for the chief engineer, even in his own technical work, to be subjected to endless hamperings and vexatious embarrassments from his Committee or Council. He is not allowed a free hand, or anything approaching it, in engineering the system to success. How many of these inter-meddling little local dignitaries there are in London who regard it as their prerogative to advise the "chief," instead of the chief advising *them*! Only a few weeks ago the Council of Islington showed, according to a report which appeared in the local press, that it has its own ideas as to what is good business-like procedure in the matter of tenders, as well as erratic notions of what is proper finance. We refer to the circumstance that after one set of tenders had been opened, some of the firms were allowed to submit fresh estimates. With councillors who allow this and irregular finance as well, is it certain that Islington, even had it the best possible engineering, could do well? They are but examples of a mismanagement which must arise in many matters which never see the light of day. We must ask, as we have asked before, that if engineers are engaged to advise a Committee, due consideration should be paid to the recommendations they may make. It is quite true that an engineer may sometimes err, but with the present constitution of municipal committees he is more likely than the non-electrical local tradesman to do the right thing.

The Dynamics of Electrons.

It has lately been a favourite hypothesis with certain physicists that the mass or inertia of matter may not be due to the presence of a material substance, but may simply be due to a disembodied electric charge on the ultimate particles, which, as far as we know at present, are the electrons. An interesting discussion of the mathematical consequences of this theory, by Max Abraham, will be found in the *Annalen der Physik*, for January, 1903.

The results obtained are not always in agreement with Newton's Laws of motion. For instance, the "mass" of an electron is not of fixed value, but increases with its velocity. The very rapidly moving electrons in Becquerel rays (having a velocity 95 per cent. of the velocity of light) have a greater mass than the more slowly moving electrons in the cathode rays. Kaufmann has shown experimentally that the facts agree with theory in this case. The mass of an electron accelerated in the direction of its motion (longitudinal mass) is not the same as its mass when accelerated at right angles to its direction of motion (transversal mass).

Uniform motion of an electron in a straight line when once established is steady or permanent. But uniform motion in a circular orbit is accompanied by a continuous radiation of energy, so that such motion must ultimately cease if not maintained by some external agent.

A continuously accelerated electron stores an increasing amount of kinetic energy which can be regained by stopping the electron, and, in addition, it radiates energy continuously; but this part of the energy is lost. There is thus a drag upon the electron, which resembles viscous friction, but depends upon *acceleration* and not on *velocity*.

An electron under way will, if quickly stopped and released, start up again of itself, and move with diminished velocity in the original direction. This, which is quite unlike the behaviour of matter as we know it, may be understood when we remember that the electron carries along with it a wave of ether stress which is not annihilated by a short stoppage of the electron.

When an electron gains a certain velocity under the action of an accelerating force, and the force suddenly ceases to act, then the electron loses some of its velocity, and continues to move at a slightly decreased uniform velocity. The kinetic energy of an electron is not proportional to the square of its velocity.

The amount of electrical energy stored in the electric field which surrounds an electron is estimated at 6×10^{13} joules (or 44 million million foot-pounds) per gram of electrons. Owing to the excessively small size of the electrons, they are always at a great distance apart in comparison with their size, so that variations of total energy due to different forms of electron aggregation are but a small fraction of the total energy. Thus the diminution of energy due to the formation of a gram of water is only one four thousand millionth part of the total electron energy. The volume integral of ether stress—which may be the fundamental cause of gravitation—is also independent of states of electron aggregation to about the same degree of approximation.

Radio-activity and the Age of the Sun.

Prof. G. H. Darwin suggests in *Nature* that previous estimates of the sun's age will have to be modified, as the result of the discovery of a new source of energy in the disintegration of the atoms of radio-active substances. Lord Kelvin's well-known estimate of 100 million years was arrived at on the assumption that the energy emitted by the sun was derived from gravitation by the concentration of its mass. Prof. Darwin estimates that the energy derivable from this source is $2{\cdot}7 \times 10^7$ M calories. If the sun were made of a radio-active material of the same strength as radium, it would be capable of emitting 10^9 M calories without reference to gravitation. This energy is nearly 40 times as much as the gravitational energy. He sees no reason for doubting the possibility of augmenting the estimate of solar heat as derived from the theory of gravitation by some such factor as 10 or 20. The geologist's estimate of the age of the earth has always been so much greater than that of the physicist, that they have generally been looked upon as irreconcilable. The multiplication of the physical estimate by 20 would bring it into very close agreement with the geological estimate. The presence of helium in the sun points to the existence of radium in its mass, so that there is much to be said in favour of Prof. Darwin's hypothesis.

Electrically-driven Machine Tools.

THE convenience and flexibility of electrical driving, and the ease with which the speed can be controlled and varied—now that high-speed tool steels are so widely used—are becoming more and more recognised; but no standard method of attaching the motor to the tool has yet been arrived at, as sufficient experience has not been gained to enable tool makers to decide upon the most suitable position.

In many American lathes, the motor is attached directly to the headstock, but English makers seem to prefer fixing it in or behind the base. This is probably with the idea of reducing vibration to a minimum, and it also entails the least alteration to existing patterns. The general adoption of high-speed cutters will necessitate modifications in the general design of machines, as most of the existing patterns are too light to stand the additional strains, and the gearing becomes very noisy. The higher the machine speed, the less the ratio of reduction between the machine and the standard motor, and consequently, in many cases, the more efficient the gearing. The most economical, and at the same time the simplest method of speed control, is by shunt regulation, and although this necessitates a motor larger than is required in some other methods, shunt control is becoming more and more popular. Motors, whose speed can be varied in the ratio of 3 to 1 by field regulation, are now quite common.

Wolverhampton Tramways.

ALDERMAN LEWIS, and Councillors Bantock, Purkyn, Weaver and E. White, opponents of the Lorain system of electric traction, have now tendered their resignations as members of the Tramway Committee, stating their reasons to be as follows:—

1. We are not prepared to accept further responsibility for working the tramways on the Lorain system owing to the increased cost compared with the overhead, as shown in the report of our own expert. We are satisfied that within a short period of time they will require rate aid if the right amounts are placed to renewals and depreciation accounts.
2. The adoption of the Lorain system does away with the hope of obtaining direct and complete inter-communication with the outside districts, which we believe to be essential to the prosperity of the town.
3. The offer now accepted is not so good as Mr. Alderman Mander's proposal, which was rejected by the Council in May last. That proposal was that the Lorain Co. should put down at their own expense, as, and when required, all new boxes and improved top plates of the larger size. The Council has now agreed to accept the present boxes, of which only 3,500 out of 6,212 will be covered by the larger top plates, the remaining 2,712 boxes will remain exposed to vehicular traffic with 1,500 new top plates of the present size but improved pattern; all but 1,000 of the new top plates having to be fixed at the expense of the Corporation.
4. We are strongly in favour of a well-tried and safe system which would admit of popular fares and produce a surplus which could be applied to the reduction of our rates.

We are glad to note that these gentlemen have the courage of their convictions. This expression of their views should go a long way towards educating the Wolverhampton public, if the latter will only take the trouble to look closely into the matter.

Gas Engines for Power Stations.

THE question of the adoption of gas plant in electric lighting stations frequently demands settlement at the hands of consultants and engineers responsible for such concerns, and on these occasions the gas engine usually fares very badly. There seems to be a tendency to regard the use of gas plant as a cheap method of commencing a supply business, which may conveniently be handed over to the tender mercies of the steam engine when it has attained reasonable proportions. This course does not appear to be justified, and can only be accounted for by prejudice or personal reasons. Quite recently a council was advised to extend with steam plant, because (*vide* local Press) the increased size of the generating units (about 200 H.P.) favoured that course. The mythical disadvantages arising from the gas engine exhausts are to be replaced by the unquestionable disadvantages (in an exclusively residential quarter) of a chimney and, very possibly, smoke nuisance.

The committee are, of course, as helpless on electric lighting questions as lambs, and trust implicitly to their consulting engineers, whose recommendations, it is not too much to expect, should be amply supported by up-to-date results obtained in actual practice.

In basing any conclusions on the working of gas engine plants, modern direct driven examples at home and abroad should in all fairness be considered. Their cheapness of operation, and freedom from exhaust troubles, are such as to hold out special inducements to those extending electrical generating plants—already gas driven from producers, which can be adapted for the use of cheap grade bituminous coal—equally as well as steam plant.

The guiding policy of using only that which one's father and grandfather found satisfactory, has resulted too often in suppressing what might have become valuable engineering developments.

The *Locus Standi* of Ratepayers.

THOSE who are unfamiliar with the details of practice before Private Bill Committees in Parliament often wonder why ratepayers who object to a scheme put forward by their local authority do not take the opportunity of voicing their objections before the Committee. The answer is, that a ratepayer cannot be heard against the Corporation seal. He is presumed to have assented to their election and to have authorised them to dispose of the ratepayers' money in whatever way they think proper. If he object to their policy, he must make himself heard at the municipal elections; but, subject to certain rights to which we are about to draw attention, he can place no further check upon the representatives of his district. One exception may be noted in passing, namely, that frontagers on a projected line of tramway may be heard in opposition *as* frontagers, but not otherwise. In a case where a Borough Council acting on its own initiation promotes a Bill dealing with some important local matter without the subject having been mooted at the local elections, and consequently without the Council having received any mandate from the electorate, the Borough Funds Act provides certain safeguards which, alas, have only too seldom been called into requisition to check the aspirations of the municipal trader. This Act provides that the consent of owners and ratepayers must be obtained before the local authority can charge the rates with the expenses of promoting any Bill. Although ratepayers on this side of the Tweed do not often make use of the privileges conferred by this Act, the fact that they can do is some compensation for their exclusion from the committee rooms. Ratepayers beyond the Tweed, however, are not in such a fortunate position, for the Borough Funds Act, 1872, does not apply to Scotland, and yet the rule of Parliamentary practice which denies the right of any ratepayer to be heard in opposition to the corporate seal apparently holds good in Scotland. In this connection mention may be made of the St. Andrew's Links Bill (1894, R. & S., 349), and the Oban Pier Order Confirmation Bill (1896, 1. S. & A., 129), where it was argued, but without success, that in view of the fact that the Borough Funds Act did not apply to Scotland, the *locus standi* rule should be modified. It is important to observe, however, that in the inquiry into the Kilmarnock tramways scheme held at Glasgow in July, 1903, under the new Scottish procedure, no objection was taken on the ground of representation to the *locus standi* of a body of ratepayers who objected to the policy of the proposal. Again, in the case of the Paisley Tramways Order in 1901, ratepayers were hard against a municipal tramway scheme, though, it is true, the ratepayers were in that case also owners, and their *locus standi* seems to have been sustained solely on that ground.

It is obvious that the exclusion of ratepayers from taking any part in Bills promoted by local authorities is necessary. To admit them would be to prolong the proceedings indefinitely. Parliament has wisely provided certain safeguards for English ratepayers; it would be but fair to extend the same to Scotland.

D

MOTOR-GENERATORS AND ROTARY CONVERTERS.

By H. M. HOBART.

(*Continued from page* 521.)*

A little consideration will suffice to show that so far as relates to obtaining satisfactory automatic regulation of the commutator voltage by means of phase regulation, there should be employed a comparatively weak armature expressed in armature ampere-turns per pole, low saturation and low armature resistance. These conditions lead to much more liberally proportioned rotary converters than would otherwise be necessary. But in order not to make out too unfavourable a case for the rotary converter, from the standpoint of regulation by phase control, the estimations have been based upon a machine with these features, and therefore of decidedly liberal proportions.

In Table I. are set forth the data assumed for the rotary converter:—

Table I.

Rated output	600 kw.
Commutator voltage	600 volts.
Number of poles...	12
Periodicity in cycles per second	25
Speed in revolutions per minute	250
Internal voltage at full load output	613 volts.
Full load current...	1,000 amps.
Full load efficiency at unity power factor ...	96 %

$$\text{Y voltage} = \frac{600 \times 0{\cdot}615}{1{\cdot}73} = 213.$$

At unity power factor the Y amperes input are equal to

$$\frac{600{,}000}{0{\cdot}96 \times 3 \times 213.} = 980 \text{ amperes.}$$

The armature winding is of the 12-circuit single type.

The alternating current component of the resultant current per armature conductor, at full load and unity power factor, is equal to

$$\frac{980}{1{\cdot}73 \times 12} = 47{\cdot}0 \text{ amperes.}$$

The assumed saturation curve for this machine is given in fig. 7. This shows for 613 internal volts, 8,900 ampere-turns per field spool, and for 600 volts, 8,600 ampere-turns.

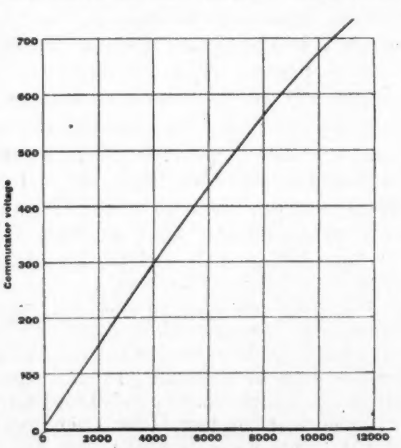


Fig. 7.

Hence the ordinates of the full load characteristic for the point of minimum current (unity power factor), are

980 amperes and 8,900 ampere-turns.

The machine has 60 segments and 60 turns per pole, consequently 20 turns per pole per phase. To replace 8,900 ampere-turns per field spool, the armature current required is

$$\frac{8{,}900}{4{\cdot}30\dagger \times 20} = 104 \text{ amperes per armature conductor.}$$

This corresponds to a total wattless current input of

$$\frac{104}{47{\cdot}0} \times 980 = 2{,}170 \text{ amperes per phase.}$$

Hence for zero field excitation, and full load output, the total current input is equal to

$$\sqrt{980^2 + 2{,}170^2} = 2{,}380 \text{ amperes.}$$

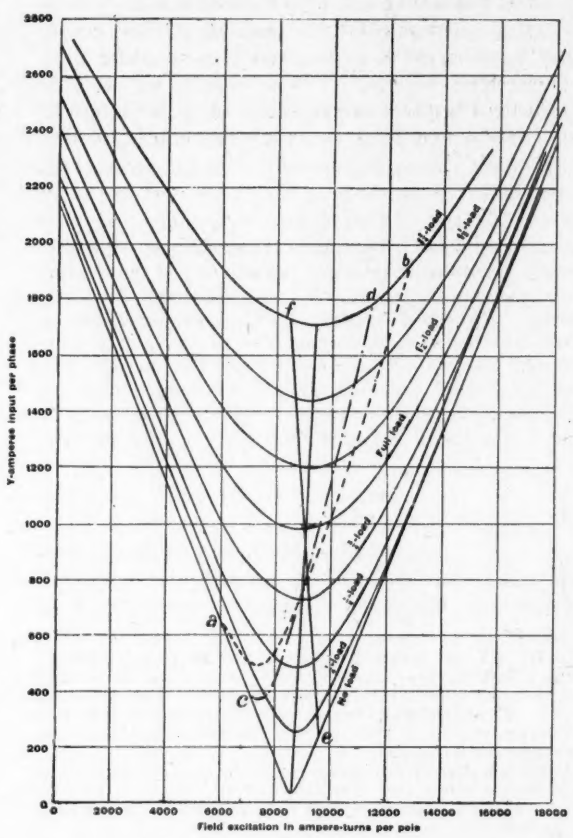


Fig. 8.

By determining in a similar manner the armature current required to replace—not the whole excitation as in the above example—but portions thereof, the values in Table II. have been derived:—

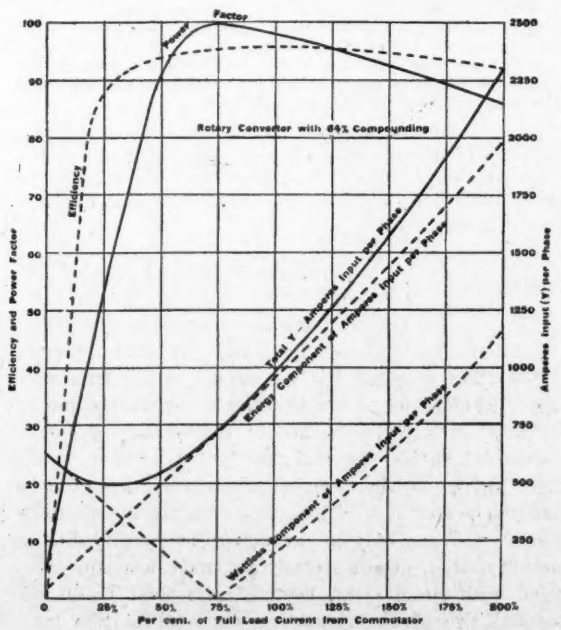

Power Factor
Rotary Converter with 6% Compounding
Efficiency
Total Y - Amperes Input per Phase
Energy Component of Amperes Input per Phase
Wattless Component of Amperes Input per Phase
Efficiency and Power Factor
Amperes Input (Y) per Phase
Per cent. of Full Load Current from Commutator

Fig. 9.

* In the small-type text explaining the diagram in fig. 6, on page 521 of the Electrical Review for September 25th, 1903, the last two words in the second line should have been "synchronous motor" instead of "rotary converter."

† This 4·30 is the constant, the derivation of which was explained on page 521 of Electrical Review for September 25th, 1903.

TABLE II.

Voltage at commutator.	Amperes output from commutator.	Field excitation in ampere-turns.	Y amperes input per phase.
600	1,000	0	2,380
600	1,000	3,000	1,760
600	1,000	6,000	1,200
600	1,000	8,900	980
600	1,000	11,900	1,200
600	1,000	14,900	1,760
600	1,000	17,900	2,380

Calculations at other loads gave the results in Table III. for the amperes input per phase at varying excitation :—

TABLE III.

Ampere-turns field exc. for following continuous-current outputs.								Y amperes input.							
0 amperes.	250 amperes.	500 amperes.	750 amperes.	1,000 amperes.	1,250 amperes.	1,500 amperes.	1,750 amperes.	0 amperes output from commutator.	250 amperes output from commutator.	500 amperes output from commutator.	750 amperes output from commutator.	1,000 amps. output from commutator.	1,250 amps. output from commutator.	1,500 amps. output from commutator.	1,750 amps. output from commutator.
0	0	0	0	0	0	0	0	2,140	2,180	2,240	2,290	2,380	2,540	2,690	2,860
3,000	3,000	3,000	3,000	3 000	3,000	3,000	3,000	1,400	1,440	1,520	1,628	1,760	1,920	2,090	2,300
6,000	6,000	6,000	6,000	6 000	6,000	6,000	6,000	650	720	820	1,010	1,200	1,390	1,630	1,880
8,600	8,690	8,780	8,870	8,900	9,040	9,130	9,210	40	255	485	715	980	1,190	1,435	1,700
11,200	11,380	11,560	11,740	11,900	12,080	12,260	12,420	650	720	820	1,010	1,200	1,390	1,630	1,880
14,200	14 380	14,560	14,740	14,900	15,080	15,260	15,420	1,400	1,440	1,520	1,628	1,760	1,920	2,090	2,300
17,200	17,380	17,560	17,740	17,900	18,080	18,260	18,420	2,140	2,180	2,240	2,290	2,380	2,540	2,690	2,860

These values are plotted in the curves of fig. 8. The points at which the broken line *ab* intersects the various load characteristics, correspond to the values of the total excitation automatically obtained when the shunt winding is adjusted to supply a constant excitation of 6,000 ampere-turns, and the series winding to give 3,850 ampere-turns at the full load output of 1,000 amperes, this being 64 per cent. compounding at full load. This adjustment corresponds to unity power factor at $\frac{3}{4}$ load. The excitations at the different loads for the machine thus adjusted are given in Table IV.

TABLE IV.—ADJUSTMENT WITH 64 PER CENT. COMPOUNDING AT FULL LOAD, AND FOR UNITY POWER FACTOR AT 75 PER CENT. OF FULL LOAD.

Per cent. of full load.	Total excitation in ampere-turns per pole.
0	6,000
25 per cent.	6,960
50 ,, ...	7,920
75 ,, ...	8,870
100 ,, ...	9,830
125 ,, ...	10,790
150 ,, ...	11,750
175 ,, ...	12,700

In Table V. are given the corresponding total amperes input per phase, the energy component and the wattless component, together with the efficiency and the power factor at all loads.

TABLE V.—ROTARY CONVERTER ADJUSTED FOR UNITY POWER FACTOR AT $\frac{3}{4}$ LOAD, AND 64 PER CENT. COMPOUNDING AT FULL LOAD.

Per cent. of full-load amperes output from commutator.	Commercial efficiency of rotary converter.	Y-amperes input to rotary converter, per phase.	Energy component of amperes input.	Wattless component of amperes input.	Power factor.	Field excitation (ampere-turns per spool).
0 %	0 %	640	25	640	·039	6,000
25 %	88·0 %	495	255	425	·515	6 960
50 %	94·2 %	530	485	212	·915	7,915
75 %	95·4 %	720	720	0	1·00	8,870
100 %	96·0 %	990	970	195	·980	9,830
125 %	95·4 %	1,255	1,190	400	·950	10,790
150 %	94·6 %	1,570	1,440	615	·920	11,750
175 %	93·5 %	1,910	1,700	872	·890	12,700
200 %	92·0 %	2,300	1,980	1,175	·860	13,650

The curves in fig. 9 are plotted from the results set forth in Table V.

(To be continued.)

ELECTRIC RAILWAYS IN EUROPE.

RESUMPTION OF THE HIGH-SPEED TRIALS AT BERLIN. 118 MILES AN HOUR ATTAINED.

CERTAIN developments in connection with electric railway working in Europe may be expected to take place shortly. Herr E. Rathenau, as representing both the Allgemeine Elektricitäts Gesellschaft and the Union (Thomson-Houston) Electricity Co., of Berlin, has started for the United States in order to return the visit paid to the German capital by Mr. Coffin, president of the New York General Electric Co., which may be recollected as having absorbed the Thomson-Houston interests in that part of America some time ago. M. Thurnauer, of the French Thomson-Houston Co., has also proceeded to the States; and it is easy to understand that a family party is assembling in New York. What these conferences will lead to remains to be seen; but it would appear that certain agreements are contemplated in relation to a permanent interchange of ideas, patents and experience, and a limitation of the markets in which the various interests may operate in the future. The electric railway question will take a prominent part in this direction; and it is said that the Americans are prepared to co-operate with the European companies in the establishment of a full gauge main line of railway as a result of the experiments, to the renewal of which reference is made below, now being made on the military railway near the German capital.

The high speed trials on the military railway between Marienfeld and Zossen, in the neighbourhood of Berlin, were resumed on September 17th, when Dr. Reichel, electrical engineer, attained rates ranging up to 107 miles an hour. It may be remembered that about a year ago the promoters of the experiments—the "Study Co." for electric express railways—were successful in reaching a maximum speed of 100 miles an hour with two electric locomotives built respectively by the Siemens & Halske Co. and the Allgemeine Electricitäts Gesellschaft, although the object in view was to accomplish 125 miles an hour. It was, however, found that the rails would not permit of runs being made at a speed higher than 100 miles an hour, the track being pounded to pieces by the high speed locomotives. Since then the Prussian military authorities have relaid the line, partly because it needed reconstruction, and partly for the purpose of allowing the trials of the electric locomotives to be continued independently of the projected high speed experiments which are to be made with steam locomotives on the same railway. The track has been re-laid with heavier rails throughout, those weighing 80 lbs. per yard having been substituted for the 72-lb. rails formerly used, while the number of transverse sleepers has been increased so that there are now 18 sleepers for each 40 ft. of line. In addition to these arrangements, guide rails have been laid down on specially constructed chairs in order to reduce to a minimum the possibility of derailment, the guide rails rising about 2 in. above the head of the track rails. Various improvements have been introduced in the electric locomotives with a view to accomplishing the considerable speeds aimed at by the tests. When the trials were resumed on September 17th the Siemens & Halske locomotive was brought into operation first, and the heavier track fully answered its purpose. Since then the locomotive of the Allgemeine Elektricitäts Gesellschaft has also commenced its tests, and

the experiments are being proceeded with six mornings a week. It is assumed as a result of the new trials that the speed of 125 miles an hour sought to be attained by the promoters will be accomplished within a conceivable period.

Since the above lines were written, further experiments have been made, and on Saturday, September 26th, the enormous speed of 118 miles an hour was attained by one of the cars without the slightest hitch, both the locomotive and the track admirably answering their purpose. The current, which was supplied by the Ober Spree works, was transmitted at 13,500 volts for a distance of eight miles, and the experiments attracted a large number of visitors, who lined the railway stations along the route. Among the visitors were a number from England, who are said to have mostly been provided with cameras, although instantaneous photography by means of snapshots appears to be a difficult matter at the high speeds which were travelled. The trials have now been suspended for a short time, in order to allow of a thorough examination of the permanent way and the cars.

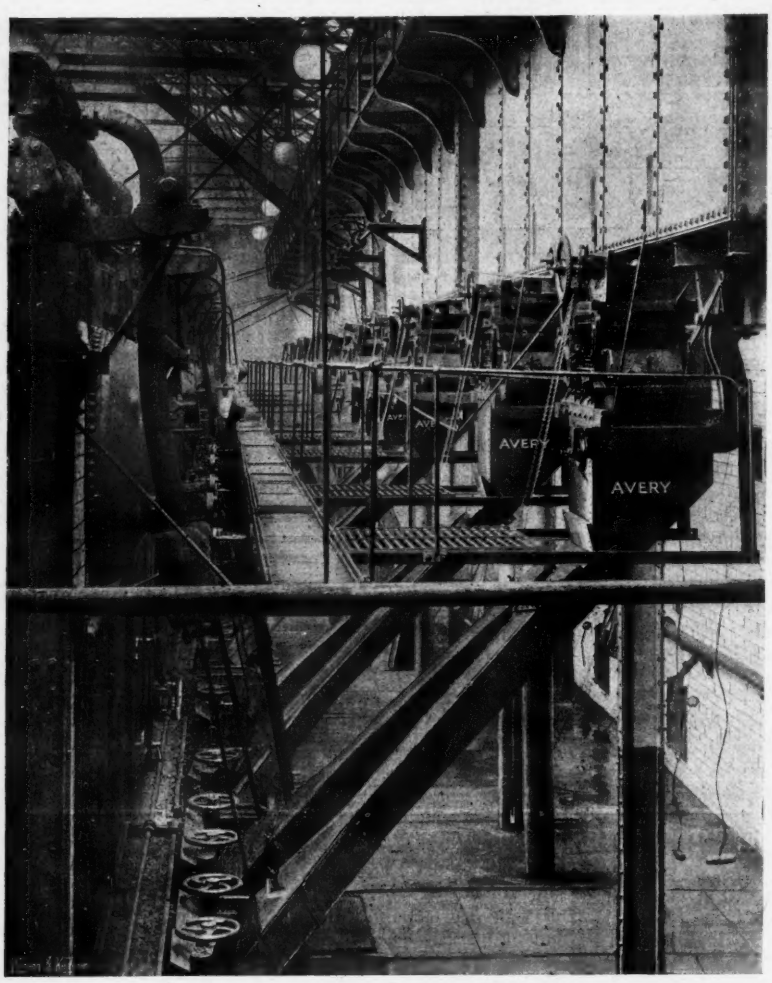
The Union Electricity Co., of Berlin, has now inaugurated a series of experiments on the Berlin suburban railway between Nieder-Schoneweide and Spindlersfeld as a result of arrangements made with the State railway authorities, the specially interesting fact being the employment of the single-phase alternating-current system for the purpose of attempting to solve the problem of electric traction on main or local lines. According to the agreement between the two parties, the company is to be permitted to make experiments for a period not exceeding two years for a consideration—the sum is reported to be £6,000—and the railway authorities have placed at the disposal of the company two six-axled coaches which have been converted into electric motor-cars. The current, which is collected from an overhead conductor, and returned through the track rails, is single-phase alternating supplied by the Ober Spree electricity works at 6,000 volts, and the motors on the cars are arranged to work at this pressure. As the experiments proceed it is proposed to couple three trailers to each motor-car so as to form trains which are to be operated at from 20 to 35 miles an hour. It is scarcely necessary to say that the trials are attracting a considerable amount of interest in technical and railway circles, the latter being of opinion that a low pressure of 500 volts is entirely out of the question for railway purposes from a financial point of view.

Various schemes for affording improved means of transport continue to engage attention in Berlin. One proposes extensions of the existing overhead and underground electric railway; a second suggests the construction of a city railway over the housetops between the north and the south of Berlin; and a third projects the establishment of a suspended electric railway on the system in use at Barmen—Elberfeld. These and other schemes appear to make comparatively little progress.

The Austrian Minister for Railways has invited all the electrical firms in that country, including the Austrian Siemens & Halske Co., the Schuckert Co., and the Union Electricity Co., to submit proposals for the introduction of electric traction on the new Alpine railways. As against this scheme it is reported that the project for the establishment of a direct line of electric railway between Vienna and Pressburg has now been definitely abandoned, as owing to the demands made by the Vienna municipal authorities, the line would be financially impossible.

The Italian Mediterranean Railway Co. is reported to have concluded an agreement with an international financial syndicate for the purpose of making inves igations in order to place before the Government a scheme for the construction of an electric railway between Rome and Naples. The existing line connecting the two cities is 154 miles in length, but the proposed new railway would only be 129 miles long. It is estimated that the cost of constructing the railway, which would be equipped on the third-rail system, would amount to £4,000,000. It is understood that the Government will introduce a Bill to deal with the question at an early date, and a subsidy of £510 per mile per annum may be granted in aid of the line.

The Belgian Government has under consideration proposals from the following for the construction of an express electric railway between Antwerp and Brussels:—M. Empain, the Cockerill Co., Siemens & Halske, Syndicat de L'Interprovincial, Bruxelles—Anvers, M. Muellender, Mr. Behr, Zollikoffer, De Vigne and De Bauw.



Automatic Coal-Weighing Plant at Glasgow.

COAL SCALES FOR POWER STATIONS.

The above illustration is a view of the boiler house of one of the Glasgow Corporation electric supply stations, and shows a row of 10 Babcock & Wilcox boilers. The usual coal bunker runs over these boilers, and between the bunkers and the boilers there is an installation of automatic coal scales, made by the well-known Birmingham firm of weighing machinists, Messrs. W. and T. Avery, Ltd.

The scale is fitted with double shutters which control the coal supply, and so work that large lumps of coal can be passed into the weigh hopper. This latter is arranged to weigh 100 lbs. or

1 cwt. of coal, and every time this exact weight of coal has been drawn from the bunker, the supply is cut off, and the contents of the weighing bucket are discharged to the automatic stokers. The scale is arranged to regulate itself to the amount the stoker requires, so that if the boiler is using varying quantities of coal, say, from 5 to 50 cwt. per hour, the scale regulates itself to the demand.

Ordinary weights are used in the weigh pan, and the beam of the scale being even-armed, the accuracy of the weighings can be regulated within 1 per cent. The rope-drive, which is seen in the illustration, is for the agitators, the use of which is necessary when lumpy coal is used. The Glasgow Corporation has another power station which is also equipped with these scales, and they are understood to fulfil every requirement.

Prior to the introduction of the complete installation, we understand that the Corporation had one machine on trial for a period of about 18 months, the working of which was so satisfactory that Messrs. Avery were commissioned to instal a further 13 machines.

The original photograph was taken by the kind permission of Mr. W. A. Chamen, the engineer-in-chief of the Glasgow station.

ON SOME PAPERS READ AT SARATOGA, SEPTEMBER, 1903.

THE American Railway, Mechanical and Electrical Association has held its first annual meeting at Saratoga. This Association is in reality an offshoot of the American Street Railway Association, and is the outcome of a desire on the part of the shop foremen, superintendents and master mechanics, or the executive staff of American Street Railways, to inquire more closely into the vital details of operation which have so much to do with the economical running of cars.

The parent Association discussed, in general, papers dealing with the whole aspect and policy of street railways, and a large section of members found that many of these papers, while not beyond their comprehension, were rather too much outside the requirements of their daily life in the shops. So, too, we find, meeting at Saratoga for the first time, the members of the Street Railway Accountants' Association of America, all yearning for a feast of specialised information such as they could not get without long waits between courses at the meetings of the parent Association.

The *Street Railway Journal*, as usual, reprints the whole of the papers and the full discussions, and we propose to skim a little of the cream off both. The length and breadth of the discussions on the papers is sufficient proof that the Mechanical and Electrical Association has been formed to some good purpose, and its annual meetings should be expected with considerable interest by British workers in the same field.

Mr. Baker, superintendent of the Boston Elevated shops, thinks that the first thing in the care and maintenance of car bodies is to give the car builders drawings of every detail, so that a car by any builder is indistinguishable from the remainder. The stock of spare parts is much reduced thereby, and after the cars are in service men can do more work in a day on them than they could if designs were continually altering.

How clearly that must be brought home to everyone who has to repair two cars built by different makers, but performing the same service under identical conditions, each having the same general appearance and seating capacity! If these two cars came into the shops after a severe collision, how often is it found that the dashboards are bent to the same sweep, that the platform bearers, the end-sills, or the doors are interchangeable? With half-a-dozen different makes of cars in the sheds, it is long odds on none of those things fitting any but the car for which they were made.

On the way in which a car is washed depends its life to some extent, and the matter is of vital importance to the paint and varnish. The methods used in America differ widely, as they do in England. On the New York Central cars are dry-wiped, and washed only on damp days. It is said that the varnish stands better under this treatment; but the Pullman Co., after a trial of dry-wiping and washing, say that little difference was noticeable after twelve months. Mr. Baker himself has the cars washed once a week in dry weather, and every day in wet or muddy weather, using cold water and as little alkali or soap as possible, and that only when necessary. It is interesting to hear that the Elevated cars become so coated and grimed with oxide from the excessive wear of the brake-shoes when going through the subway, that it is impossible to remove the dirt without the varnish.

Other roads seemed to favour the use of some kind of soap, chiefly linseed-oil soap with a little alkali in it to clean off the dirt better. The chief objection to this is that car-washers always will use too much soap if they get a chance. The remedy is to give out the soap and alkali in the form of a very weak solution; otherwise the varnish is damaged, and soap lodges in all the corners and crevices. On one line, at least, washing with water was carried to such an extreme that the floors rotted out. Possibly, on account of difference in the excellence of the work, the number of cars cleaned per diem per man varies greatly. At Boston one man cleans seven cars, and that with between 80 per cent. and 90 per cent. of cars in constant use, while another road comes a little below this record with six cars per man, and one gets near the vanishing point with one car one man. Without knowing the local conditions and the size of the cars, it is impossible to make any real comparison.

Car cleaning is work which lends itself naturally to piece-work, but inspection must be keen and rejection of bad work certain, as with all piece-work.

One or two notions respecting painting might be worth the consideration of European managers. At Boston, for instance, a car is given two coats of finishing varnish on the exterior before leaving the paint shop, but is not given the third coat, which most people consider necessary, until it has been in service for six months. That gives the varnish time to settle down to conditions, and makes a hard, smooth and durable surface for the final coat. The author of the paper made a strong point, when he introduced the subject of painting, by saying that it is quite unnecessary to bring street cars up to the pitch of private carriages. All that is required is to ensure "durability, cleanliness and wholesome appearance at a minimum cost," and, to obtain these qualities, he advocates the use of nothing but the best material.

Another speaker made a similar point when saying that he aimed to build a car with the smoothest and plainest interior possible. That does not mean discomfort or ugliness, but leads to less dust and dirt, and so to greater cleanliness and less expense in cleaning.

It is of the first importance in painting that the foundation should be well and truly laid. The priming must be well rubbed in over every portion of the car, and the filling must be done with great care.

Influential speakers discountenanced the use of rubbing varnish, which, they think, makes a brittle surface.

Our experience of English tramways rather leads to the impression that many of the smaller concerns, and some of the larger ones, take insufficient interest in the process of painting, the manager being content to leave the details of the work, without question, to the painters, and to gaze with a kind of picture-gallery rapture on the glossy sides, decorated with many-coloured coats of arms, as a car leaves the shop. Neither is it recognised to any serious extent how much the life of the paint depends on the treatment of the varnish in washing. Car cleaning is considered, too often, as a cleansing process pure and simple, instead of a combined cleansing and preservative process.

Long ago in these columns we expressed a wish that the sloppy American style of wiring to be found in most English cars, keeping company with American equipments, might be replaced by a less crude and safer style, and we find that this desire has spread to America, and has been fostered by the recent electrical fires in tunnel trains.

One large system is putting fire-proof mats at the back of lighting switches, and is baring the leads into the switches for 6 in., putting on asbestos stockings.

The Boston Elevated has equipped four cars with 1¼ in. pipe, the motor leads encased in 1¼ in. lead pipe, which runs from the usual linen hose covering the main cables, under the seats and direct to the motors. The hose itself is fastened up under the seats. On other leads a special fireproofed cable is used.

Mr. Old's paper on "Improvements in Street Car Motors" was short and pithy, and the discussion was long and valuable.

The most interesting portions are those referring to the

abandonment of pit work, the use of solid gears, and the acknowledgement that oil is better than grease for lubricating motor bearings.

The call on motor manufacturers now is for a motor of which the top half can be lifted with the least disturbance of the truck. This allows overhauling to be done from the floor, instead of from a pit, as the general practice has been hitherto.

We are convinced by the results of actual experience that floor work is both better and cheaper than pit work, if proper tools and tackle are provided. We refer, of course, to overhauling and general repair work only. Inspection pits are essential always for much of the everyday adjustment and cleaning.

We have hardly considered the possibility of using solid gears as against split gears in England, and the idea seems to be not at all widespread in the States. The cast-steel split gears undoubtedly are open to objection, in that the bolts clamping the two halves on the axle are liable to stretch enough to loosen the gear. Sometimes, too, a nut drops off, or a bolt-head shears, with the inevitable result that the teeth of both pinion and gear are badly mauled, and the armature shaft is bent.

A solid cast gear would be bored out and pressed on to the keyed seat just like a wheel, and would never budge or drop nuts around. The idea sounds good, but there was much questioning at Saratoga as to the method of getting the gear off the axle again. It is obvious that the gear cannot be removed unless a wheel is removed too; to this we should have little objection, as gear and wheel should last nearly the same time, barring accidents; but the difficulty arises if it is found impossible to remove the wheel and the gear one at a time. Wheels are obstinate masses sometimes, even when persuaded by a 100-ton press, and have to be "flogged" with sledges in addition on occasion. What would happen, then, with double the work to do?

Nevertheless such gears actually are running, and the relative cheapness of their manufacture, added to the certainty of their remaining intact and tight, might make it cheaper to use them instead of the split gear, even if they have to be split off the axles.

It has been evident for years to most English tramway engineers that oil lubrication is better in every way than grease. In fact, if the American motors, so largely used here in the earlier days, had not been designed with grease-boxes, it is doubtful if anyone would have used grease. On account of the severity of their winters, the Americans had some excuse for using a lubricant which must be always inferior to oil. Many roads have used oil for a long time, but the question of the relative merits of grease and oil still occupies a leading position in discussions of this nature.

The testimony offered at the Saratoga Convention is all to the effect that oil increases the life of the bearings three or four times, and that hot boxes cease to trouble.

If there is any road in England still using grease, that road is not paying as well as it might.

A sore trouble on many tramways has been the constant breaking of gear cases. This may be caused either by the low-hung rigid cast-iron case encountering a high sett, or some such obstacle; or the bolts holding the two halves together, and both on to the motor case, may slacken, when vibration will break the top or bottom half. As may be supposed, the mortality among bottom halves is much higher than among top halves. Now the cost of renewing even a half case would buy dinners for many a poor man, so that any modification promising improved life is to be welcomed. Several were described at this convention. One gentleman makes the top half of malleable iron, and cuts about 4 in. off the lower half, to which he fastens a No. 20 sheet-iron bottom. This gear case is as rigid as the original; the part most subject to blows is made to bend instead of breaking, and the top half, which was often broken by the shock transmitted through the lower half, is made more elastic. The first cost of this case will be more than before, but the renewals will be much reduced.

Cases constructed entirely of sheet-steel are being introduced in this country, and if the joints can be made lastingly tight, they should prove satisfactory; although we are inclined to prefer, on the face of it, the design of the President of the Convention, which consists of a light angle frame, curved to the form of a case, the sides being made of $\frac{5}{16}$-in. wood and the periphery of $\frac{1}{8}$-in. wood, so thin on the periphery as to allow a loose bolt to break through instead of being caught between the gears. The structure is elastic, the weight is reduced by one-half or more, vibration and noise should be decreased, heavy maintenance charges vanish, and, chief of all advantages, the cases can be home-made.

It does not appear that this type of case has been tried at all extensively on the cars of the undertaking where it originated, so that we have still to hear of the disadvantages, which are not anticipated, but always arrive. They will consist chiefly, in our opinion, in the difficulty of preventing leakage of grease, but we believe that the design is much nearer perfection than anything seen before.

The paper on "Shop Kinks" contains no very new matter, as the discussion testified, for the only "kinks" which seemed to interest the members were the re-insulation of field-coils, and testing armatures by the alternating field method. The latter is not at all new in this country, nor in the States for the matter of that, but it might be used more extensively in tramway repair shops with advantage.

Whether or no it pays to re-insulate scrapped field coils depends entirely on the prices obtainable for scrap and new copper, and the cost of labour in re-insulating. We have some experience of sending old coils to cable makers to be cleaned and double-cotton covered, and do not think the game worth the candle, if indeed it is not more expensive than buying new wire.

The author of the paper practises burning off the cotton, opening out the coil over a long bar, scraping the wire clean and then lapping it with tape.

During the process the individual coils have not lost their shape, and they are returned to their original positions easily. A taping machine is used also, and the coil is unwound to be passed through it.

Several speakers were familiar with these methods, one having used a taping machine for seven years. This gentleman burns the old covering off not only to get rid of the covering, but also to soften the wire, which, as is well known, becomes brittle with use. He does not apply any extra tension to the tape, and uses a thin tape gummed on one side.

Another gentleman using the same method is able to turn out eight coils per diem with six men. He finds it necessary to press the coils to get them tight (using the wheel-press for the work), and locates bad work with the alternating field.

Sometimes, when motors are too small for their work, cotton-covered fields soon bake and burn out, and asbestos-covered wire has to be used. Unfortunately, pure asbestos tape of sufficient strength to withstand application to the wire is hard to find, and it is impossible often to add more than a single cotton covering. A speaker in the discussion on the paper on "Improvements in Street Car Motors," mentioned above, stated that he had managed to get a special asbestos yarn after much trouble. The wire is coated with a compound which helps the asbestos to cling to it. This wire is wound on a metal former, each layer being coated with a mixture of shellac and whiting, and the fully-wound field bound up tightly to prevent swelling, and put in the oven. Then the coil is taped, dipped in insulating compound, and waterproofed as much as possible.

As a general rule field coils do a lot of damage before they fail altogether. On a number of systems the lower coils in the old G.E. motors, for instance, are constantly in contact with mud and water. Between overhaulings there may be time for damp to penetrate to the wire, with the result that the first few layers gradually short-circuit. It is obvious that the armature will not be improved under those conditions. Possibly it burns out, and, alas! possibly the shop foreman does not order the fields to be removed with the armature, so that the real cause of the mischief remains to work havoc with another armature.

The last paper read, entitled "Car-shop Practice," produced such a valuable discussion, and is productive of so many more remarks, that it must be dealt with in a separate article.

Finsbury Technical College.—The evening classes, lectures and laboratory work, &c., recommence on October 5th for the new session.

THE EMERGENCY BRAKE.

JUST as surely as night follows day, so surely is any accident on a tramway succeeded by a regular deluge of letters from inventors who have patented, or who want to patent, the only contrivance that will make such accidents impossible for ever after.

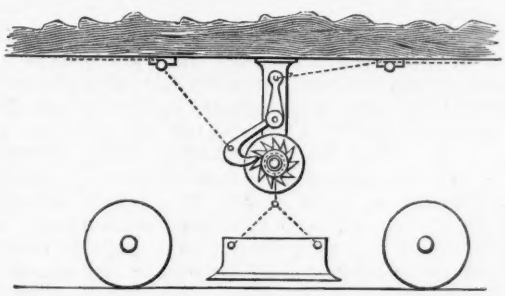
We have all heard of that celebrated "Electrical and Mechanical Engineer," hailing from Burnley, who has invented, or, at least, advertises inventions relating to every part of a car, overhead equipment, or track, and illustrates them in the style of the melodramatic poster.

Naturally the last run-away car brought him out again as fresh as ever, and our mail was heavier by eight closely-written quarto pages all about the utter uselessness of any brake except his own.

Extracts from the Board of Trade Inspectors' reports respecting the last three or four accidents are requisitioned to prove this, to the writer's satisfaction at any rate, and Dr. Louis Bell is rung up again. Then follows a description of *the* brake in the inventor's best style.

This description is remarkable chiefly on account of the longest sentences ever written in any language. (After careful study we believe the letter to be written in a patented form of English.) Two of these sentences occupy more than three pages of the letter, and we have told off one of the staff to do breathing exercises for a month before we allow him to take the risk of reading them.

Out of the most luxuriant growth of verbiage that ever we have seen we take the following:—"They are on the principal (*sic*) of those used on carts: a shoe with a sole a little wider than the wheel which mounts it when dropped in front, going down hill and is held by a chain. If two were applied, one to each wheel, the cart could not travel."



On account of the complicated nature of this invention, we reproduce the drawing sent.

The grandeur of this invention is well shown by the fact that the shoes are 18 in. long and *broad*, and are in addition "file-faced." Naturally, the next two sheets are taken up by an explanation of the drawing. Then the writer says:—"The car is, of course, arrested abruptly, but, as the driver will have confidence in them, and his equanimity will not be disturbed, and can call out to the passengers to 'sit tight,' and, although they may become more closely acquainted with each other by being bumped together, and perhaps feel somewhat undignified and indignant, they will not be injured by a collision." With what a delicate touch of humour is the deceleration of the passengers portrayed, and how comforting it is to know that none of them will be injured by a collision; or do the words hide some subtle double meaning?

The writer is as much at home with French as he is with English, and means to show it when he underlines *contretems* and uses it in a sense as yet undiscovered by the Academie.

In case managers do not comprehend what risks they incur while they are without the new shoe emergency brake, we quote an ominous sentence near the end:—". . . the liability will not be placed on the motorman, but those above him, if they do not provide them, as, in my opinion, there are none equal; or that can be compared with them, and are so reliable, efficient and powerful, consequently the liability will become very serious and may not be confined to compensation for injuries, but manslaughter, if not for a more serious crime."

We await, with some impatience, the day when the neglect to use this Burnley gentleman's "shoe brake" will be made a capital offence. Now that we have given the device full publicity, there can be no excuse for not making use of it, and we hope that every gallows in the country will be worked overtime if further backwardness is shown. The only alternative to the gallows should be a ride in a car ending with an application of the emergency brake described above.

CORRESPONDENCE.

Priority in Oil Break Switches.

In the paper read before the British Association recently by Mr. W. B. Woodhouse, it is said that "the first oil break switch to be put into practical use was at the Paderno power station in 1897," and that "this was designed by Messrs. Brown, Boveri & Co."

This statement should have been qualified to apply to the Continent only, because it is well-known that oil break switches were used in this country earlier than 1897. This company designed oil break switches in 1894. The first large switch gear made which contained oil break switches was installed by us at the City of London E.S. Co.'s works at Bankside. The switches were erected and tested in 1895, and the complete equipment was put into constant use in the following year; and it has been giving—as far as we are aware—satisfactory results ever since. Originally the gear consisted of 60 panels, each suitable for a maximum capacity of about 750-KW. at 2,000 volts, but it has since been extended to about 80 panels of the same design.

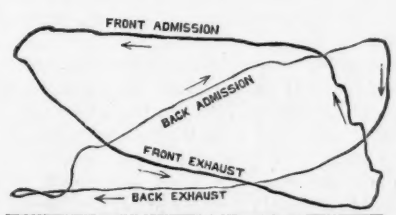
It may also interest your readers to be reminded that Mr. Ferranti's patent for "electric switches in which the contacts are immersed in oil or other insulating fluid upon breaking," was applied for in 1895.

Ferranti, Ltd.

Hollinwood, Lancs., *September 22nd*, 1903.

A Unique Steam Engine.

When recently called in to report upon the plant of an old works, using a number of small steam engines to drive separate shops, it was necessary to make some trials of the various engines. One of these, which was said to be 42 years old, gave such an extraordinary indicator diagram and was generally in such a bad state, that its case may be interesting to your readers and instructive to the users of machinery as showing how extremely unwise it is not to keep a close watch upon the performance of their engines, &c. Had this been done in the case which is referred to, many hundreds of pounds would have been saved, as it was



easy to show that the saving in coal per annum, as the result of installing a more economical engine, would have paid for such a new engine every year!

The engine was a simple, horizontal, double-acting, non-condensing one with an ordinary D slide-valve and Watt governor, governing by throttling. The cylinder was 12 in. in diameter, and the stroke was 24 in. Neither the cylinder nor the steam chest was lagged. The slide-valve was loose on its spindle, the play being about 1 in., and hence the extremely late admission as shown by the accompanying indicator diagram. On removing the back cylinder cover it was possible to pass a wooden 2 ft. rule between the piston rings and the cylinder walls. This space on measure-

ment proved to be ⅛ in. wide, tapering to nothing on either side, the extreme arc of the gap subtending an angle of about 120° at the centre of the piston.

A. S. E. Ackermann.

Westminster, *September 24th*, 1903.

An Aspect of the Fiscal Question.

In his recent address to the British Association, to which you have already referred, Sir Norman Lockyer brought a grave and well-merited charge against the men of science in this country in their capacity of citizens, to the effect that they did not organise, and so put themselves into a position to bring pressure to bear upon the Government towards the furtherance of objects of general utility. Sir Norman, it will be remembered, was speaking of educational matters only, but it is clear that his accusation has a wider significance. By the very nature of his training and consequent habit of thought, the man of science sees things in a different light from the man of commerce or the party politician; and if he were to take part in a parliament of his peers, questions would be discussed in a broader and more exact spirit, free from the personalities and vulgarities which disgrace the meetings of so many local bodies (especially in the metropolis), and to a large extent free from the class or party manœuvres which waste the greater part of the time of the House of Commons.

It is very depressing to see that the overwhelming majority of our fellow citizens are not only devoid of the power of "scientific," *i.e.*, precise and logical thought, but that they are also unwilling to allow their early prejudices and original party sympathies—and what is extreme party feeling but prejudice?—to be weakened or even assailed. Take, for example, a morning suburban train filled with a miscellaneous collection of City men; each passenger is studiously reading a daily paper, an avowed, strenuous, and, in some cases, almost unscrupulous party organ. The philosopher at once jumps to the conclusion that each party reader is poring over a paper representing the opposite party view, in order that he may see the strength of the enemy's arguments and his own weaknesses. Indeed, he is doing no such thing; he is busy acquiring a more or less narrow and bigoted creed, and congratulating himself on having the intelligence to hold that creed, which he thinks his own. Other readers with more intelligence are so obsessed with a sense of their own importance—not necessarily their individual importance, but the importance of the class or section of business to which they belong—that with, perhaps, the best will in the world, they are unable to see the bearings of any question except in so far as it affects themselves and their class; and whether they study the paper which most nearly reflects their views or not, they speak and vote as if theirs was the only important interest in the country.

Now, although most of us—not men of science alone—are, especially after the events of recent years, more or less keenly alive to our duties, privileges and responsibilities as citizens of the British Empire, we have, most of us, to earn our living, to maintain our wives and families, and to educate our children as well as possible. We must, therefore, and we have a perfect right, while not neglecting the welfare of the community at large, to look after our own pockets, which means the pockets of everyone whose income is made on lines similar to our own. It seems, accordingly, that men of science should not simply combine to form a representative and militant body for the propagation of scientific views because those views, in our opinion, explain what the country as a whole needs; but that we should combine—as a trades union, the cynic will immediately say—because the promulgation of those views will benefit us first. It appears to follow from this, and if we were to combine and take measures to put our opinions regularly before the country, we should only be another party or one-sided and narrow-minded organisation, seeing everything only from the standpoint of the laboratory or our banker's pass-book. But although the single man of scientific training is, after all, only human, has a stomach and a pocket, and cannot claim to be wholly free from class or business prejudice; a joint assembly of men of science, embracing, say, the electrician, chemist, engineer, physician, statistician, historian and geographer, would have as entirely divergent personal or class interests as the two political parties at Westminster, and the outcome of their deliberations would be an impersonal view, a logical view, a highly-intellectual view, a view which, being "scientific," would tend to the benefit of the nation.

But the point we are coming to is that the opinion even of a solitary, properly-trained, broad-minded, well-read man of science is likely to be better balanced even on a matter outside his own special department of inquiry, especially on a fiscal question, than that of the best single man of commerce, or the spokesman of the most enlightened workmen's trade union. Putting aside the greater power of logical thought which his training has given him, his pocket is less interested in the matter. Nearly all sections of the community have self-interest in questions of fiscal policy; the maker or seller of things (*i.e.*, the workman, shopkeeper and the manufacturer); the man who supplies or handles the money required in the process (the capitalist and the banker); and the party politician who supports his party in order to gain office or honours from that party. But what is our position, we who earn our living by fees? And how does that other larger section of the people stand which is in receipt of salaries, clerks, cashiers, salesmen, non-wage-taking employés generally? We and they are in the same situation here. From our aspect there has been a general depreciation in the value of money during the past five or 10 years, for with the same gross income we are much worse off than we were. The merchant and shopkeeper have put up their prices, organised labour has clamoured for and won higher wages, until their additional receipts balance their increased expenditure. But the consultant, the industrial and the commercial salary taker, the brain worker generally, asks and gets only the same payment that he did in Mr. Gladstone's time; and some of us, as even Mr. Carnegie would admit, are important members of the population.

If, therefore, it is our duty as public-minded citizens to put our highly-cultivated brain-power and general intelligence at the service of the community, and after having discussed rationally, impassionately, and to the best of our lights, the advisability of making any changes in our fiscal system, as well as the probable effect of such changes (if any), to give our digested opinions due publicity—if that is our duty, and we cannot deny it, it is equally our duty or our right to see where we shall stand in the matter. It is comparatively easy for any workman or guild of workmen, for any manufacturer, for any importer or exporter, for any party-led politician to forecast whether, and if so, to what extent, he shall personally derive any gain or loss from any alteration in our present national system; but where do we "come in?" It is notorious that salaries exhibit the highest coefficient of friction known in the money market—especially when the force is applied in an upward direction. Those of us who are employed in factories are probably much better off than pure consultants in attracting to ourselves any share of any additional profits which may be made. But those of us who are consultants merely—and surely we deserve some consideration—seem to be in a position where we stand to derive no advantage from any benefit to the general trade of the country which may follow a change in, or a maintenance of, our present fiscal system. If, in consequence of a change in, or of a refusal to change, our existing Free Trade methods, the commerce of the country diminishes or languishes, we consultants shall have fewer fees to collect, and we shall be worse off, even on the assumption that we are able to maintain our present rates of payment; but if, in consequence of a change or no change in our methods, trade prospers and grows, our commercial friends will at once say that they have no longer need of our services; for (to the keen, but narrow business mind) the extra prosperity will be obviously due to purely political causes, over which the man of science has admittedly no control.

F.

Electricity v. Gas.

With reference to "College Court's" letter in last week's issue, we suggest that another reason why gas is adopted instead of electricity for lighting new dwelling-house property is because the gas mains are laid into any district

where building has commenced, in anticipation of consumers, whereas very few authorities will lay electric light mains until sufficient connections are guaranteed to cover the cost, plus 20 per cent. The old proverb, "A bird in the hand is worth two in the bush," appeals very forcibly to the builder of cottage property who wants to let his houses practically as soon as the roof is on, and who naturally prefers gas, which he can obtain without any restrictions or conditions being imposed, to electricity, the supply of which is hedged round with all sorts of guarantees of minimum consumption, number of consumers, and very frequently part payment of the cost of connection.

R. J. Nicholson & Co.

Manchester, *September 26th*, 1903.

Capping Casing.

As an old reader of your paper, I should be very much obliged if you could give me any advice on this subject. The mains super. and tester of the company who supply the district I am working in with current, insists on having capping screws put in on the outside of 1½-in. casing; it makes it very awkward to do so, as the fillets of the 1½-in. casing are so thin, and one has to get the screws so near the edge of the capping that it very often splits, perhaps at the last one, and all that capping has to come down, and the work be done again. I have had 10 years in the line as wireman, and have always put capping screws in the centre of 1½-in., but 2-in. and over I always cap at the sides. As most of the tests come out at infinity there is nothing to grumble at in the insulation, so I presume it is a bit of contrariness on the official's part. There is nothing mentioned about that in the company's rules, and what I want to know is, has he power to order a contractor as to how he shall do his work in the matter of putting screws in the position he likes to order, as I have worked under nearly all the London Supplies, and have never had any question like that, provided the job came up to test?

Worried.

[The screws should be put in the centre of 1½-in. casing. —Eds. Elec. Rev.]

Smoke Abatement.

In reference to Mr. Daniell's letter in your issue of September 11th ult., the writer, in summing up, says:—"What is the good of fining steam users for creating a smoke nuisance if we cannot show them the remedy?" But if it can be shown that there is a remedy, I suppose he would continue fining them. I have no interest in any smoke appliance, save as engineer to a large firm in Lancashire; I quite agree with him in condemning forced draughts and hollow bars, and I might add moving and rocking bars, but I believe in sprinkling stokers and suitable stationary fire-bars. I do not believe in sprinkling stokers that use springs and tappets to throw the coals on to the furnace simply for this reason, after they have worked a short time they fail to do their duty, on account of the springs getting weaker, and the tappet wearing. Then the fireman has to help them, as they fail to cover the fire-bars, and allow cold air into the flue. Another great fault is that of depositing the coal on the dead-plate, causing the fireman to open the fire-doors every few minutes to push the coal into the furnace, and by doing so, making black smoke; the wear and tear on the spring and tappet sprinkling stokers are rather heavy. In my opinion there is only one sprinkling stoker which is perfect; it is made by Whittaker, of Burnley. The coal is thrown on by revolving shovels, which never vary in throwing the coals all over the furnace equally. No coal is deposited on the dead-plate, and when the door is opened to relieve the fire, by rake or fork, which is only done about every hour or two, there is no coal on the dead-plate, you are moving only in red fire, therefore no black smoke arises.

In wear and tear it beats all other sprinkling stokers hollow. It sends a third less coal on at one time than any other, has an equal measure, and is easy to regulate; you can stop one flue in a moment to clean off, and keep the other flue running. No cold air goes through the fire-door, or any other part of the machine; the fire-bars are stationary, and are the best I have seen. The next point to consider is making the most steam, and entirely doing away with black smoke; to do this you must have sufficient draught. In ordinary mill chimneys the draught under the fire-bars ranges from 500 to 600 ft. per minute; in order to do away with smoke you must have 1,100 to 1,200 ft. per minute, and the very best way to get it is by putting in an induced draught fan, which will give draught sufficient to take all the burning material out of the coals, make plenty of steam, save coal and do away with the black smoke in conjunction with the stoker. 15 per cent. can be saved with these appliances, as I have proved, which means about 60 per cent. on the outlay, and the machines will work well for 25 years with very little wear and tear; as there are very few wearing parts they can be made new again at a small expense. There is a remedy for the production of black smoke, and it ought to be enforced by the magistrates, seeing that it will pay the steam users to do it.

Richard Ashworth.

Automatic Fire Alarms.

To reply to M. Guarini's letter in your issue of the 18th would simply oblige me to repeat much of what I last wrote, and this would hardly prove of interest to your readers. He writes with a knowledge of Continental conditions with which I am unfamiliar, and I have the advantage conferred by daily contact with the fire service and industry in this country. It is quite possible that these conditions are widely divergent, but so far as I am concerned, I am unable to say anything about the state of the industry, its limitations and privileges in Europe. My remarks apply to Great Britain only.

M. Guarini has drawn an entirely wrong conclusion from my paper so far as Mr. Siemens is concerned. I did not seek to discourage the use of street alarms, but simply to draw a comparison between the specific nature of the information conveyed by the automatic alarm as against the general or district call transmitted by the street box. It is not the fact that street alarms are decreasing in use, and I hope it never will be. They are a city's contribution to the minimising of fire waste, as opposed to the systems adopted by individuals for their own protection. Both can develop side by side, and the existence of the one is no justification for the absence of the other. Possibly M. Guarini has only seen the garbled version of my paper circulated by the British Fire Prevention Committee. So much had been "edited into" the printed copy circulated before I was aware of it at the Congress, that I read from my manuscript, and forbade the inclusion of the "expanded" version in the official minutes of the Congress.

M. Guarini assumes impossible conditions. It is useless speculating upon what disadvantages would follow the direct connection of every house in London with the brigade stations, because none know so well as those connected with the industry that such a state of things will never happen. I shall be glad if ever the automatic fire alarm becomes as general as the telephone, and the thousands of these in use do not seem to have interfered with daylight in the manner suggested. Small houses, buildings occupied by a number of tenants, or single tenants with short leases, dwellings, &c., where insurance rates are in the neighbourhood of 1s. 6d. per cent., will never become general devotees of the automatic fire alarm with brigade connection. Landlords, sitting comfortably with their rent insured by the tenant for a year in advance, will make no contribution toward the cost; and insurance companies make no reduction yet in this country—I mean the big tariff offices (although they all allow our New Zealand clients a reduction of 10 per cent.); so that there are many and substantial reasons for refusing to consider what would happen in an impossible contingency.

If the line to the brigade is not in working order, then I cannot pass a signal through. We anticipate this difficulty by using powerful external gongs at the buildings protected, so that the police or by-standers can send the alarms over the municipal alarm wires, but this is simply precautionary—our second line of defence. I have never known a line to fail. I insist upon metallic circuits, efficiently insulated, and carried upon stringers when following aerial routes, or upon metallic pairs in conduited cables underground. The same difficulty besets telegraphy, but the difficulty M. Guarini anticipates is so negligible that nobody neglects its use on this account.

E

No, I am not exercised over the subject of interference in wireless telegraphy, but, like every other student of the profession, I am watching its development. The sooner the practical difficulties are acknowledged and dealt with, the sooner will the commercial success of the science be assured. I am glad to see that Edison and other great scientists are now identifying themselves with the wireless fraternity, because this augurs well for the simplification and safeguarding of the invention in the future. All the same, those of us who have not altogether failing memories have not forgotten the mix-up at the Yacht Race.

As to the matter of economy, I don't think I should have been inclined to touch upon this matter except that M. Guarini hints at the deliberate concealment by me of a material fact. M. Guarini writes: "He tells you that the maintenance amounts to from £3 to £10 per subscriber, but he is silent about the first cost of the establishment of the line, which it would be interesting to know." Possibly the fault is mine, but if it is it was quite unintentional. I have not the REVIEW by me to refer to, but what I intended to convey was that the first cost of the wire, with the interest, cost of fixing and up-keep, is included in the annual charge. In other words, no installation put in by me has been debited with the cost of the wire, but the lease from the Telephone Co. or from the Corporation is all inclusive. There is no first cost, if you like to take it that way, the annual charge is the capitalisation of the whole. This has never exceeded £4 a year for our longest one route circuit, or £7 a year where two independent circuits, overhead and underground, have been taken to the fire station from the same installation. M. Guarini states that the price of his transmitter is 500 fr. for similar distances, ours is rather less than half this sum; his station set is about 1,000 fr., ours does not exceed 600.

So far as putting telegraph operators into the fire stations is concerned, M. Guarini hardly knows what he contemplates. Duty is continuous in the fire service, 24 hours a day, seven days a week, and this is worked in three shifts. Assuming that the license of the Postmaster-General has been obtained, and that the local authorities have agreed to accommodate M. Guarini's staff of operators, has he any idea where he would be in the matter of cost? It is pretty safe to take it that there are not one hundred installations of automatic fire alarms in contact with all the brigade stations in the United Kingdom—I mean irrespective of the system, my own and everybody else's—and of this number the distribution is so wide that there are not four stations with more than five connections apiece. Glasgow, which will soon reach 25 of my own installations, is an easy first; but even taking this as the most favourable for the purpose of comparison to M. Guarini, how will the salary of his staff of operators compare with the cost of our metallic circuits and indicators, which require no addition to the brigade *personnel*?

I am quite willing to take up the wireless method of transmitting alarms of fire when any advantage can be obtained from it. At the moment, dealing with the conditions which exist, if the merit claimed was indisputable, the requirements of the fire service and considerations of economy would prohibit its use in this country.

Geo. H. Oatway.

Glasgow, *September 28th*, 1903.

Tangential Traction.

I have just read the comments which you made on my letter on this subject, in your issue of the 18th inst. Permit me to make some explanations which, I hope, will throw further light upon the facts. In brief, you declare that "tangential traction" is commercially impracticable, because it is too costly and too complicated. In my humble opinion, it is necessary to consider first and foremost whether "tangential traction" fulfils in principle its object, which is to avoid all the drawbacks inherent to other modes of traction, especially for high speeds. If so, the questions of cost and of apparatus pass, so to speak, into the second place. Now, this point has been fully discussed in my article, and, so far as I know, has not been contested. In reality, the great merit of MM. Dulait, Rosenfeld and Zélénais lies not in their invention of tangential traction—since it appears that numerous inventors have thought of it before them—but rather in having overcome the enormous practical difficulties which presented themselves in the solution of the problem. I will now deal with the several objections which you raise.

First, with regard to the prime cost; I stated in my article that a line 50 km. long for a speed of 150 km. per hour would cost 19,500,000 fr., according to the inventors—that is, 390,000 fr. per km., not a great amount considering the high speed attained. The cost would be about double that of the underground conduit. It is necessary besides to bear in mind that the over-all efficiency would be 68 per cent., whilst—always according to the inventors—it would be 54 per cent. on other systems. This relatively good result is explained by the absence of transforming sub-stations. Another factor of which—besides many more—it is absolutely necessary to take account, is the total absence of danger to the person of passengers and others.

The objection as to the great number of stators I made myself to M. Zélénais. He answered that in commercial working it was not necessary that the stators should be so close together. It suffices, in fact, to lengthen the trains or to provide them with a great number of propellers in such a way that the train never leaves one before having reached another. Even this last condition is not absolutely indispensable, the train being able, in certain cases, to reach the following stator by virtue of its momentum.

The question of the winding of the stators for high pressures was examined in my article. I said there, in fact, "The entire length of the track is divided into sections of suitable length, each containing one or more blocks of stators. All the stators in one section are connected in series; the three wires of the three-phase winding of the first stator in each section are connected with the distributors placed along the track, and the three ends of the last stator winding are connected with the contact blocks of an interrupter." Hence, a section of 50 stators wound for 1,000 volts each, in series, would readily allow of the use of a pressure of 50,000 volts.

I agree with you that the question of interrupters is very delicate. It is a matter of practice and experience. However, according to the inventors, the interrupters have already worked for a long time without a hitch.

The question of "entrefer" and of the rails supporting the propellers has also been dealt with in my article. It is there stated, in fact, that it is not at all necessary to have recourse to special rails. I have, indeed, said "this precaution, however, is, in M. Dulait's opinion, superfluous, as the principal rails laid on the foundations of the stators to a great extent ensure the constancy of the air-gap."

In conclusion, I think that, by the present and by my article, I have shown that if tangential traction has still some weak points, capable of amendment withal, it has, on the other hand, such advantages as if put in the balance would turn the scale—in favour, moreover, of MM. Dulait, Rosenfeld and Zélénais.

E. Guarini.

Brussels, *September 22nd*, 1903.

Aberglaube.

Several months have passed since all who were privileged to hear Sir Oliver Lodge's wonderful address were carried away by his mastery, and the apparently unanswerable arguments he used. But where is your Sir Rowland? I am one of a large class who, without scientific knowledge, live by the application of electricity and cannot avoid harbouring theories of our own, the origin of which may or may not be of the "generally accepted" character, more or less based on the earlier researches and speculations of scientists. We ought to be informed as to whether the new theory may now be regarded as that adopted by the whole scientific body and thereby lifted beyond the pale of discussion, or if we may look for an exposition of opposing theories from other high authorities. Otherwise we shall be in danger, perhaps, of falling into the same position as those who have for ages accepted theological dogmas from force of habit.

It may be useful if I give my own theory, so far as it is capable of bearing the name, as a sample of the sort of beliefs which exist as almost self-created and somewhat nebulous

outcomes of old familiar theories. I have regarded the passage of an electric current as the transmission of a state of tension or stress set going among the atoms of matter in a manner analogous to the operation of other manifestations of power, heat, light, sound, &c. We know of varying degrees of density being possible in almost all known forms of matter, and I imagine all atoms to be susceptible to the stress spoken of according to their density. Of necessity, I fall back on an ancient if not outworn aphorism, "Nature abhors a vacuum," appending to it a further assertion that nature has no knowledge of any nearer approach to the abhorred thing than we have, but only of greater or lesser degrees of attenuation of matter. At the extremity of this attenuation (hereafter to be discovered, maybe) perhaps the ultimate atom of matter will be found, christened ether or anything you like, and recognised as capable of construction into any known form of matter, and of transmitting any know manifestation of force.

I believe I have heard even the etheric theory spoken of as a dogma, and seek leave to class the corpuscular theory of electricity along with it. Both dogmas to be reverentially regarded as very convenient, and likely to do duty for some time in bridging an awkward gap between the present time and that when there arrives a clearing away of what I cannot help regarding as present errors of scientific speculation, in the direction on the one hand, of too gross a materialism, and on the other of mysticism.

The liberty I ask, will, I hope, compass the permission to do without the dogmas in cases where one's imagination will not stand the strain of the adoption of a corpuscular theory of electricity in the absence of a similar one for heat, light, sound and even gravity.

T.

Aston Meter Specification.

My attention has been called to the article in your issue of August 28th, and in accordance with the suggestion contained in the last paragraph of that article, I have made inquiries from all the meter manufacturers, and I am very gratified to find that there was no ground for the pessimistic views of your contributor. The manufacturers are unanimous in stating that there has been no increase in their tenders due to any obscurity in the specification.

Jos. Ansell,
Clerk and Solicitor, Aston Manor U.D.C.

Birmingham, *September 25th*, 1903.

L.C.C. Steam Engines.

If it be supposed that these engines will provide power to drive 500 cars each, the load factor, when one engine alone is at work, will be about 90 per cent. or even more, and load variation will be gradual, and the obligation for the governor to act on the L.P. valve, as well as on the H.P. valve, is probably far less obligatory than the reviewer of the specification appears to think.

His expressed opinion as to the superiority of the vertical engine over the horizontal type is also not supported by practical experience, and no one has yet shown that there is reduced wear and tear with vertical engines.

As regards space occupied, far too much may be sacrificed to this idea, which underlies the general junk shop appearance of many electrical stations.

In all large stations the difficulty is to put in boilers within the length occupied by the engines, and so far as space is concerned, one might as well use horizontal engines with all their facility of attention, as vertical engines which present many practical difficulties. The boiler difficulty has been solved, in a fashion, in American stations, and unfortunately in some stations on this side, by putting boilers on upper floors, a course which does not commend itself to many engineers. Fault is found with the length of the steam passages between high and low pressure cylinders, but so long as an intermediate receiver is thought desirable, its volume is partly made up of this pipe, and the argument as to length is unconvincing and inconclusive.

The placing of the high pressure cylinders at a slight incline to compensate for the bending of the crankshaft, can be met in the low-pressure cylinders by a similar lateral inclination of the low-pressure crosshead guides, surely not a very difficult problem to solve. Allowance for bending of the crankshaft was never made in large engines of the geared type, because the fly-wheels were then much lighter than present-day rope rims and much narrower. The rope rim widened the span of the main bearings, and difficulties began to appear in these, and over twenty years ago the advantage of canting in the main bearings was pointed out by the writer and carried out first probably in the engines of a Lancashire mill. Mr. Inglis also brought out several bearings to effect the same end automatically. This inclination need not therefore be looked on as presenting serious difficulty.

Obviously, in an overhung crank pin the diameter must be large, but too much is made of the pin becoming spiral under the two stresses at right angles. The two stresses are not coincident in their respective maximum amounts. If thought necessary the outer length of the pin could be slightly barrelled to ensure central bearing of the rod. It might be thought a complication, but the horizontal connecting rod could be short jointed to the head of the vertical connecting rod in order to shorten the pin. This would, of course, produce a small bending moment upon the vertical rod, and to such an extent would be objectionable. It would, however, reduce the length of the pin, for it would not double the unit pressure upon this. The design of such a pin must always be a matter of some considerable compromise between conflicting tendencies.

With regard to balancing difficulties, the non-central position of the fly-wheel will prevent balance in a horizontal plane, but ordinary balance of rotation will be secured probably as well as in most types by the use of a single balance weight 112½° from each crank. (Valve gear not included would slightly alter this angle.)

Every form of engine has its defects, but there is much less to be urged against this so-called American type than against the actual American three-crank type now under repair in a Scotch tramway station. By the way, too, in his anxiety to see American peculiarities, has not your reviewer overlooked the origin of the Chelsea turbines?

The turbine will in time probably supersede reciprocating engines, but it may be as well to see Chelsea at work first, and there are improvements yet to be made.

W. H. B.

[Our correspondent's arguments have the air of an apology for the defects of the type of engine in question, many of which he virtually admits; in fact, if nothing better can be said for it than he puts forward, our criticism is amply justified. To describe methods of mitigating defects is not to prove them absent. We believe that in our article we fairly stated the *pros* and *cons*, and that in our conclusions we shall have the support of the great majority of British engineers. In reply to the half-hearted assertions of "W. H. B.," we may point out that, in case of a sudden loss of load, the necessity of governing on the low-pressure cylinders will be made manifest in the presence of large receivers and condensers.

Our correspondent's remarks on the horizontal engine would lead us to suppose that he is predisposed in their favour. The great popularity of this type of engine, in company with the Lancashire boiler with the manufacturers of the North, has been its principal recommendation; but on the score of frictional losses, ease of starting up, even turning moments, and economy of space, such a type does not compare with the steam turbine for electrical purposes. Our correspondent, in common with many mechanical engineers, appears to possess ideas on the requirements of electrical work which, to say the least, appear hazy, and his use of the term "general junk shop," as applied to an electrical station, is incomprehensible.

The argument as to space occupied is quite inapplicable. There is no difficulty in arranging the boilers suitably without piling them in tiers, and we can cite practical examples of such arrangements.

We fear we cannot agree to be bound by cotton mill precedents, however admirably these installations may have

been designed. The problems to be faced in central station work have practically no features in common with mill-work.

The eccentric suggestions with regard to the crank pin and big end, we think, need no discussion.

Our correspondent states that "ordinary balance of rotation" can be easily secured; of course it can, but by what means can the reciprocating masses be balanced? They move in two planes at right angles, and cannot be balanced.

To aver that another type of engine is *worse* than this is but a lame defence. As for our "anxiety to see American peculiarities," we assure our correspondent that these are precisely what we don't want to see in British stations! The origin of the Chelsea turbines was not a thousand miles from Newcastle, and their place of manufacture (Trafford Park) is generally regarded as British. As for possible improvements—must we wait until perfection is attained? —Eds. Elec. Rev.]

[A correspondent wants the address of the London agents for small Porter motors (American manufacture).—Eds. Elec. Rev.]

SOUTH AFRICAN NOTES.

(From our Johannesburg Correspondent.)

Ladysmith.—The arrangements for formally inaugurating the electric light plant were that it should take place on August 29th, the switching-on ceremony being performed by Mrs. Farquhar, whose husband, when mayor of the borough, played a very leading part in getting the idea taken up. Public lighting was to commence on the date mentioned, but private consumers could not be accommodated until one week later. The generating station is located in Market Square, and its equipment comprises three Robey locomotive type boilers, each of 30 H.P, having special fire-boxes fitted to consume Natal coal, and two Willans engines driving four electric generators. The contract for the electrical work was given to Messrs. Hubert Davies & Spain, at £8,326, and the operations are now being carried out under the direction of Messrs. Reeves and Manning. Mr. J. Roberts, A.I.E.E., of Durban, is the consulting engineer, and it was from his specifications and plans that the scheme was first started upon, though it has since been increased, and extensions to the value of £2,000 have been made from specifications by the borough electrical engineer, Mr. J. Stanley White, of Manchester, who will also take charge of the whole of the system when completed. The four generators are each of 425 KW. capacity, and they are of the multipolar type supplied by the Electrical Construction Co., of Wolverhampton. The current will be distributed on the three-wire overhead system. Each pole will contain five wires, but two will be light switch wires for the street lighting. Already the anticipated demand has so considerably increased that in Murchison Street it has been thought advisable to fix a cable of 19 strands of sixteenth wire in place of the No. 6 cable which was at first intended. The work of establishing house connections goes on rapidly, and no fewer than 50 are already completed. Many of the cables have been carried into streets where there is as yet no private demand, so that all the ratepayers, even on the outskirts of the town, may have the benefit of the street lighting; 100 32-C.P. incandescent lamps will be distributed over the town, one on each alternate pole, except in dangerous parts, such as the Convent Hill, where a light will be fitted on every pole. Four arc lamps have been ordered. A further 75 incandescent lamps have been ordered for placing on the poles in the extensions of the original scheme. The charge to private consumers will be 1s. per unit.

Cape Electrical Engineers and the Metric System.—In September the Cape Town section of the I.E.E. had an adjourned discussion on metric weights and measurements. The motion brought forward at a previous meeting by Mr. Horne, viz., "That this society recommends the adoption of the metric system of weights and measures for use within the Empire," was supported by Mr. C. Proctor Banham, who spoke from a practical experience of the system, and detailed the various advantages that he considered would accrue from such a change. Messrs. Denham, Legg, Horn, Pickering, and the chairman, Mr. J. P. Edwards, also spoke for and against the motion, which was ultimately carried by a large majority. A paper was contributed by Mr. C. Proctor Banham, M.I.E.E., entitled "The Measurement of Resistance." The author treated the subject from a central station, rather from a laboratory point of view. An interesting visit was recently paid by the members of this local section to the new works of the Cape Times Co., Ltd., in Keerom Street, where the very efficient equipment was inspected with much appreciation.

Cape Town Electric Lighting.—A Cape paper gives the following figures relating to the working of the electricity supply system here:—During the month of July 166,683 units of electricity were generated at the City Electric Lighting Works, of which 31,147 were consumed for the purpose of street lighting, 116,365 by private consumers, 2,000 upon the works, 8,000 units for meters, and 9,171 distribution losses, &c., the net revenue accruing from the supply of current to private consumers being £4,925, as compared with £4,064 for the month of July, 1902, the average price paid during July, 1903, being 10·15d. per unit, and for the year from January 1st to July 31st, 1903, 10·9d. The total number of private consumers has been 1,091, and the equivalent number of 8-C.P. lamps 67,000; whilst motors have been employed to the extent of 1,063 H.P., as compared with 810 private consumers, with an equivalent of 54,700 lamps, and motors to the extent of 642 H.P. during July, 1902.

Scarcity of Telegraphists in South Africa.—Some very important evidence on this subject was placed before the Select Committee of the Legislative Council which has been considering the matter of Civil Service appointments, by Sir Somerset French, Postmaster-General, who was asked whether it was a fact that a large number of telegraphists from England had had to be engaged. In replying Sir Somerset said:—"A very large number; in the 12 months ending June 30th last we imported 102 from England, and we trained in our Colonial schools 61, or a total of 163 men to fill about 250 vacancies. We have from 20 to 30 resignations, deaths, and removals in a month. At the present time we have not succeeded in filling all our vacancies. By adopting the plan of taking on lads who fail to pass the entrance examination, on condition that they continue their studies, and are successful in qualifying, before their year's training is completed, we have been able to bring up the number of Colonial boys in our schools to 145. We have advertised all over the Colony. We constantly insert displayed advertisements in the Cape papers to try and attract the Colonial lad to the Post Office, but he does not seem inclined to come in sufficient numbers. If any lad, within the limits of age and otherwise eligible, offers himself at any place in the Colony where he can be trained, he is taken on, provided he can pass the educational examination; the rule of the department being never to import men if a sufficient number can be trained locally. It takes at least three years' experience before a telegraphist can be placed in charge of a moderately busy main wire, and when the work doubles, as ours has done in two or three years, you can understand how difficult it is to keep pace with requirements. Although during the past three years we have done everything in our power to meet the demands made upon us, we have occasionally had wires idle and messages delayed, and, of course, public complaint. The Post Office has, I venture to say, gone through in that time the most trying period in its history, through excessive pressure of work and the extreme difficulty of adequately coping with the extraordinary development which has taken place."

Potchefstroom.—The *Cape Times* of September 6th says:—"The Government having extended the time for the receipt of tenders for the electric lighting of Potchefstroom until the end of October, there is considerable dissatisfaction among the members of the Health Board, and it is quite possible that the Colonial Office will be requested to withdraw the whole scheme. This will mean that either the matter will stand over for the municipality to deal with, or the private company, which has already got the light installed at a number of business houses, will have the chance of supplying the whole town."

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Sept. 30th, 1902.		Week ending Sept. 29th, 1903.	
Adelaide	Value £523	Alexandria	Value £77
Alexandria	73	Amsterdam	65
Amsterdam	23	Auckland	30
Bangkok	26	Bombay	93
Bombay	557	Buenos Ayres	267
Buenos Ayres	74	Calcutta	1,269
" Teleg. mat.	349	" Teleg. mat.	990
Calcutta	57	Cape Town	801
Cape Town	671	" Teleg. mat.	1,036
Channel Islands	10	Christchurch	43
Chinde	30	Demerara	75
Copenhagen	168	Durban	2,274
" Teleg. wire	192	" Teleg. mat.	625
Durban	1,565	East London	2,219
" Teleg. apparatus	174	Fremantle	2,310
East London	21	Hong Kong	292
Foochou	451	Kobe. Teleg. cable	298
Fremantle	176	Lisbon	481
Gibraltar	86	Lyttleton	50
Gothenburg. Teleph. cable	127	" Elec. machinery	490
Halifax. Teleg. cable	13,489	Madras	48
" Teleg. mat.	137	Malaga	43
Hamburg. Teleg. mat.	300	Malta	85
Hong Kong	222	Melbourne	251
Kobe	53	Paris	278
Larache	123	Perth	143
Lisbon	35	Port Elizabeth	70
Melbourne	26	Rotterdam. Teleg. wire	11
Odessa	207	St. Thomas	64
Perth	894	" Submarine cable	1,812
Port Elizabeth	62	Shanghai	219
St. Petersburg. Elec. machinery	64	Singapore	133
" Teleg. mat.	874	Stockholm. Teleg. wire	48
" Teleg. wire	147	Sydney	506
Stockholm. Teleg. wire	144	" Teleg. mat.	120
" Teleph. cable	65	Timaru	370
Sydney	470	Valparaiso	16
Syra. Teleg. instruments	50	Wellington	285
Yokohama	426	" Teleg. mat.	666
		Yokohama	184
		" Teleg. mat.	119
Total	£23,070	Total	£18,696

Foreign Goods Transhipped.

Gothenburg. Elec. appa. Value £179 | Durban. Elec. mat. Value £132

Veritys' Fittings.—We have received from Messrs. Veritys, Ltd., two well compiled and arranged catalogues relating to their electric fittings department. The principal publication consists

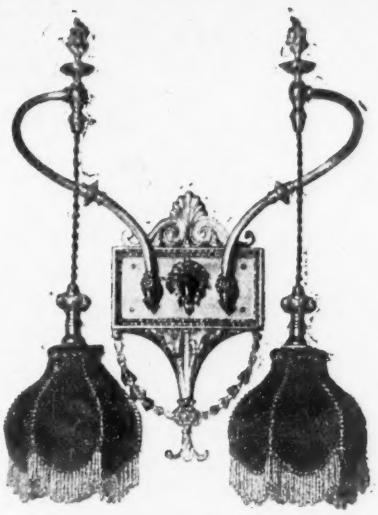


Fig. 1.

of a catalogue of electric light fittings of every class, containing 164 pages of designs suitable for all requirements, and we should say suitable for all tastes and all pockets. The second is devoted to their Aston electric radiators. Both books will no doubt be applied

Fig. 2.

Fig. 3.

for by a large number of contractors, who will make use of them in their everyday work. We illustrate herewith a few selected designs. Fig. 1 shows a graceful two-light wall bracket, in the "Adam" style finished in imitation gilt, with silk shades with bead fringe. Fig. 2 represents a hand-beaten three-light ceiling fitting, which is supplied in brass or antique silver, with cut-glass bowl. Fig. 3 shows a quaint hall lantern, finished in either brass, antique copper, or oxidised silver; it is suspended by a special form of chain through which the wire is threaded. An application to Messrs. Veritys, Ltd., at any of their various addresses, will ensure the catalogues being forwarded.

New Works at Bradford.—The reiteration of the old proverb anent "rolling stones gathering no moss" is notorious among engineers, and especially electrical engineers, as a reason for "putting up with" out-of-date works and machinery, and it is always interesting to find a case where a firm has, without hesitation, "pulled down its barns and built greater," so to speak, and that with improving results. Starting under another name and achieving no particular success in a small factory in Bradford, the Phœnix Dynamo Manufacturing Co., under new proprietorship, moved out to more commodious works at Hubert Street, Leeds Road, from whence they were impelled by circumstances to remove to Joseph Street, where the extensions gradually filled up the available space, and obsolete tools were ousted in favour of up-to-date machinery. These works being employed to their full capacity, it became necessary to look out for larger premises, which were eventually secured at Thornbury. These new works are admirably adapted for economical working, and a final clearance of old, and the installation of new tools enables the company to cope with both small and large work satisfactorily. The new works are now in full swing, and the following list of work in hand and recently completed is sufficient justification of the latest move:—

Bradford Corporation.—300-kw. set for direct coupling for Sunbridge Road destructor works. Two switchboards for 1,000-kw. sets for Valley Road works. Fifteen 10-h.p. motors and 84 special "P.D.M." starters. *Wednesbury Corporation.*—Two sets of motor-generators, each consisting of 115-h.p. two-phase motors direct-coupled to 75-kw. continuous-current generators. *Graham, Morton and Co, Leeds.*—They have recently supplied the whole of the motors in connection with the cranes, and are now on with the whole of the motors for shop driving for this firm's new works, the aggregate h.p. being considerably over 200. For a Cleckheaton firm they have in hand a 100-e.h.p. generator with various motors for new works. For three mills in the district they have 60-kw. generators in hand for each, with motors, switchboards, &c. For a Nottingham firm they have 65 kw. in two generators for direct coupling. For Dewsbury firms they have two direct-coupled sets on order aggregating 80 kw. They have also over 200 h.p. in hand for special motors for electrical coal-cutting, and altogether the horse-power in motors, &c, which they have on order totals over 3,500 h.p. In their polyphase department they have, among other jobs, a complete mono- and polyphase equipment for the Bradford Technical College, and they are also supplying polyphase machines to the Yorkshire College and to the Lancaster Technical College. Among work recently completed may be mentioned the dynamos and the whole of the motors for Messrs. Meldrum Bros'. new works at Timperley; the whole of the steam plant, motors, boosters, &c., for the Burnley Workhouse to the specification of Messrs. Shepherd and Watney; the plant for Sir James Kitson, Gledhow Hall, Leeds, to the order of Messrs. Wallis & Watson, Leeds; a 250-kw. generator for the Lidgett Colliery Co., &c.

The Phœnix Co. has recently been registered as a limited company with sufficient capital to ensure a successful effort in the keen competition which prevails in these times.

Trade Announcements.—Messrs. James T. Donald and Co., Ltd., engineers and steel merchants, 35, McAlpine Street, Glasgow, have been appointed as the sole agents of the Bell Rock Belting Co. in Scotland, for the sale of the Bell Rock improved sewn cotton duck belting (constructed with two solid round edges), Bell Rock balata belting, English oak-tanned leather belting, hair belting and patent link belting. Messrs. James T. Donald & Co., Ltd., hold large stocks for immediate delivery.

Messrs. Edward Le Bas & Co., iron, steel and metal merchants, have removed from 18, Billiter Street, E.C., to Dock House, Billiter Street, E.C.

Mr. James Richardson, late of the G.E.C. and of Veritys, has joined Messrs. Baxter & Counter, as traveller for London and South Coast.

As most of Mr. Edward Brand's customers are located in the North, for their convenience he has removed his office from London to 63, Lancaster Avenue, Manchester.

Messrs. Dick, Kerr & Co., Ltd., have removed their head offices, &c., from 110, Cannon Street, to Abchurch Yard, Cannon Street, E.C. The branch office addresses are:—Northern Assurance Buildings, Albert Square, Manchester; and the Tasker's Engineering Co., Blonk Street, Sheffield.

The National Tube Co. has removed from Dock House, Billiter Street, E.C., to 71 and 72, King William Street, E.C.

Mr. Hal Williams announces that he has taken Mr. Walter Bridges into partnership, and that the firm will be known as Hal Williams & Bridges, consulting and supervising engineers. Mr. Bridges, who was for some years with Messrs. James Simpson & Co., engineers and contractors, London and Newark, has, until recently, been chief engineer to Messrs. Belshaw & Co., engineers and contractors, Westminster, S.W., and has had special experience in all classes of electrical and mechanical engineering.

E.P.S. Batteries.—The Electrical Power Storage Co., Ltd., has received the order from the Brighton Corporation for the extension of its storage battery, also an order from the Corporation of Sunderland for the storage battery for Ryhope Asylum.

Books Received.—"The Steam Turbine," by R. M. Neilson. Second edition. London: Longmans, Green & Co. 1903. 10s. 6d. net.

"Elementare Vorlesungen über Telegraphie und Telephonie," by Dr. R. Heilbrun. No. 5. Berlin: Verlag von G. Siemens. 1903.

"Engineering Preliminaries for an Interurban Electric Railway," by E. Gonzenbach. New York: McGraw Publishing Co. 1903. $1.00.

"Spon's Engineers' Price Book, 1903-4," by Thos. G. Marlow. London: E. & F. N. Spon, Ltd. 12s. 6d. net.

"Compressed Air," by W. C. Popplewell. Manchester: The Scientific Publishing Co. 7s. 6d. net.

"Hardening, Tempering, Annealing and Forging of Steel: A Treatise on the Practical Treatment and Working of High and Low-Grade Steel," by Joseph V. Woodworth. Westminster: Archibald Constable and Co., Ltd. 1903. 10s. net.

"The Practical Testing of Dynamos and Motors," by Charles F. Smith. Manchester: The Scientific Publishing Co. 5s. net.

"Luna" Nernst Lamp.—A new form of Nernst lamp has been brought out by the Electrical Co., Ltd., of 122—124, Charing Cross Road, W.C., under the above title, which is intended to take the place of small arc lamps. This lamp is generally similar to the ordinary A type, but the burner is entirely different—the heater being horizontal and entirely above the glower, which it heats by radiation. Thus, the heater offers no obstruction to the light from the glower. The "Luna" is supplied for ½ ampere 200—260 volts, 1 ampere 100—160 volts, or 200—260 volts, and 2-ampere 100—160 volts, for direct current only; we are informed that the inefficiency is less than one watt per candle—in fact, only ·88 watt in the higher voltage lamps. We have for some time been using one of these lamps experimentally, and find its light admirable to work with. The glower lights up within one minute of switching-on. Provided that the life of the glower proves satisfactory, and the efficiency is maintained at the remarkably high value claimed for it, it cannot be doubted that the "Luna" will become very popular, as it combines the convenience of the glow lamp with an efficiency approaching that of the arc. The "Luna" and A-type burners are not interchangeable.

Catalogues and Lists.—Messrs. De Dion-Bouton, Ltd., of Great Marlborough Street, Regent Street, W., are now issuing a new catalogue of their dynamo and motor combinations from 1¾ to 8 h.p. for lighting buildings, charging batteries, driving machinery, and for movable installations; also their pump motor and belt pulley motor combinations. An illustrated description of these machines appeared in our issue of February 20th, 1903, but anyone can obtain one of these well-illustrated pamphlets (31 pages) on application to the above address. Although the list only describes three of the applications of the De Dion-Bouton motors, they are used in great variety for other purposes, and are claimed to be suitable for any work where a small amount of power is required in a portable and convenient form. They are also being supplied for motor launch combinations.

Messrs. Brooker & Goss, Ltd., of Freezywater, Waltham Cross, have sent us a copy of their electrical instrument price list. It has some very distinct illustrations of Brooker's patent moving-coil type dead-beat instruments, ammeters, voltmeters, motor-car instruments, cell testers, shunts, and so on.

A list of arc lamp couplings and winches, and indoor electric light fittings has been issued by Mr. G. Braulik. He has also brought out a new edition of his electrical sundries catalogue, giving cuts and details of small accumulator novelties, medical coils and details for motor-car and other work.

We have received from Messrs. Walter Locke & Co., Ltd., of Locke Buildings, Calcutta, one of their advance catalogues of electrical accessories, fittings and stores. The firm is energetically pushing electrical installation business in Calcutta, and the present catalogue is an evidence of this fact.

The International Electrical Engineering Co., of Clun House, W.C., has placed before us an illustrated price list, fully describing its "Universal" electric crab.

Liquidation.—A meeting of the South Shields Electrical Engineering Co., Ltd., will be held at 18, Grainger Street West, Newcastle-on-Tyne, to hear an account of the winding-up from the liquidator, Mr. M. Stainton.

Auction Sales.—On Wednesday next, October 7th, Mr. F. Bowen will sell certain electrical plant and machinery by auction at Aldersgate Street, E.C. Some particulars are given among our advertisements to-day.

On October 21st, Messrs. Wheatley Kirk, Price & Co. will offer the machinery, stock in trade, fittings, &c., of the Electric Lighting and Fittings Corporation (Liverpool), for sale. Particulars are given among our advertisements.

Imports of Telegraph Cable and Apparatus.—The value of the August imports of foreign telegraph cables and apparatus into this country amounted to £8,381, the second largest monthly total recorded this year, and comparing with only £3,591 in July last. The imports for the eight months ending with August have reached a sum of £42,112.

German Electrical Machinery Imports and Exports.—A noticeable shrinkage has taken place this year in the imports of foreign electrical machinery into Germany, the returns for the seven months ending with July last showing a total of only 451 tons, as compared with 903 tons in the corresponding period of last year. On the other hand, the exports of German-made electrical machinery continue to show a steady improvement, they having increased from 7,211 tons in the first seven months of 1902 to 7,541 tons in the seven months ending with July last.

Cable for Sale.—The Canterbury local authority is offering 2,200 yards of cable for sale. See our advertisement pages to-day.

Forthcoming Books.—A new edition of *The Dynamo* in Whittaker & Co.'s specialist series is expected to be published shortly. Since the last edition the authors, Messrs. Hawkins and Wallis, have entirely revised it.

Messrs Chas. Griffin & Co. are about to issue new additions of *Applied Mechanics*, Vols. I. & II., by Prof. A. Jamieson, M.Inst.C.E.

ELECTRIC LIGHT AND POWER NOTES.

Abingdon.—The Lighting Committee having considered the terms of the offer contained in Messrs. Suter & Co.'s letter of July 16th, for an installation of electric light in the borough, were unanimously of opinion that it would be unwise to accept the same. It was agreed that the necessary notice be given to the Board of Trade and the report was adopted. The Committee had also considered the notice received by the Council from the Abingdon and District Electric Lighting Co. of its intention to apply to the Board of Trade for a prov. order for an installation of electric light in the borough, and found that in order to secure a *locus standi*, the Council should give formal notice on or before January 15th next, and it was essential that they should be empowered to obtain the necessary professional assistance to advise them whether or not it would be desirable to insert any clause in the prov. order.

Brighton.—The T.C. having failed to dispose of any of the 270 electricity meters which have been in use for 10 years, and are obsolete, the value of them (£1,400) has been written off.

Bristol.—With the object of ascertaining the demand for current, a canvass has been made at Fishponds, beyond the boundary of the existing mains. The result is so satisfactory that the Electrical Committee has decided to extend the mains.

Brussels.—The new central power station of the Brussels electric tramways was recently opened in the presence of the King of Belgium. It is intended to help the two former sub-stations of Rue Brogniez and Ixelles, and the new sub-station of Rue Verte. The new central station, installed by the Thomson-Houston Co., contains four double-compound tandem engines. The coal is transported automatically from the canal of Charleroi to the boilers. Three-phase alternators of 1,500 kw. at 6,600 volts are installed by the Union Electricitäts Gesellschaft, of Berlin. There are three 110-kw. exciters, two being worked by asynchronous motors running at 6,600 volts, the third by a steam engine. From the central station energy at 6,600 volts is brought to the sub stations, transformed to 410 volts, and converted into a continuous current at 550 volts.

Cambridge.—In 1890 the Corporation of Cambridge obtained an electric lighting provisional order for the town. Soon afterwards the order was transferred to the company, and the undertaking has been running for nearly 11 years. The following table gives an adequate view of the financial progress of the undertaking for the last six years:—

Year.	Gross revenue from sale of current.	Average revenue per unit sold.	Total cost per unit sold.	Number of units sold.	Dividend.
1897	£5,856	6·35d.	3·75d.	221,507	6
1898	6,791	6·26d.	3·42d.	260,307	7
1899	7,733	6·22d.	3·04d.	298,392	7
1900	8,822	5·93d.	2·74d.	357,435	7
1901	9,395	5·90d.	2·58d.	382,224	7
1902	10,585	5·89d.	2·33d.	431,379	7

The feature of this table is the steady reduction in the total costs per unit sold as the magnitude of the company's business increased. Between 1901 and 1902 there is a difference of 1·5d. per unit. In this connection it may be noted that seven Parsons steam turbines, coupled direct to Parsons alternators, are installed in the generating station. The Cambridge station was, in fact, one of the first to be equipped with a type of prime power now in great favour with designers of big electric power undertakings. For several years past the company has regularly put aside each year sums for depreciation ranging from £300 to £750, making a total of £4,250 set aside for decaying capital. Out of that total £1,059 has been written off the capital account, leaving a depreciation fund of £3,190. Additional powers of electricity supply were obtained last session for a considerable district surrounding the Cambridge area, and a large number of applications for electric light have come from that district.

Carnarvon.—A L.G.B. inquiry into an application made by the Town Council for sanction to borrow £17,000 for the purposes of a proposed electric lighting scheme has been held. Many members of the Town Council were present, as were also the spokesmen appointed by the ratepayers' meeting, and a number of ratepayers. The National Electric Wiring Co., Ltd., with whom the Corporation had proposed coming to an agreement for carrying out the works, were represented by their secretary and others. Mr. Vincent appeared on behalf of a number of ratepayers for the purpose of opposing the originally proposed scheme. At the opening

of the proceedings, the Mayor made an application for an adjournment of the inquiry in view of the fact that an alternative scheme had now been presented to the Council which they had not yet had an opportunity of fully considering.

Mr. Vincent supported the Mayor's application, saying he appeared on behalf of several ratepayers to oppose the original scheme.

The Inspector said the L.G.B. had been asked by telegram and by letter to postpone the inquiry, but the wording of the application left it optional to them to postpone or not. Although an alternative scheme had now been proposed, that was no reason why the inquiry into the general question of electric lighting for the town should be postponed.

It was ultimately decided to postpone the inquiry to a future date.

Clitheroe.—The T.C. has decided to apply to the Board of Trade for a provisional order to enable it to supply electricity for public and private use within the borough. The generating station will be on the site of the present gas works. The gas manager, Mr. R. Barrett, recently stated that for purposes of power electricity had a great future before it, but for lighting purposes electricity would not oust incandescent gas. The cost of electric current was far greater—in fact, almost double that of gas—and he did not think it would pay a private company to put down plant in Clitheroe. We compliment Mr. Barrett on his modesty.

Croydon.—The Lighting Committee considered an application for an extension of the electric main in South Norwood Hill, to supply three houses recently erected there, which have been wired to receive the electric current, the applicant (the builder) stating that it is his intention to erect 16 more houses and wire them for electricity supply. The estimated cost of the extension is £112, and in this instance the Committee are unable to obtain the usual undertaking guaranteeing the required 15 per cent. income on the outlay; but in view of the probable demand which will come upon this main if extended, the Committee recommend that the work be carried out subject to an undertaking being obtained from the builder to wire for electricity supply all the houses he erects on South Norwood Hill.

An application for an extension of the main to Torridge Road, Thornton Heath, was also considered, where the applicant (the owner) has 14 newly-erected houses already wired to receive the current, the applicant stating that it is his intention to erect and wire for current a considerable number (70) of additional houses in this road. The estimated cost of the extended main is £293, and the Committee recommend that the work be carried out. The Committee also recommend that this road be lighted by incandescent electric lamps, and that a main for the purpose be accordingly laid at an estimated cost of £148. The price charged for the lamps will be the same as for the incandescent gas lamps. The report was adopted.

Dartford.— The Board of Guardians has decided to have the workhouse extensions lit by electricity. The Gas Co. informed the Guardians that they could supply gas at about a quarter of the cost of electricity per candle-power, but it was pointed out that if electricity were used £30 a year would be saved in renovation and repainting

Devizes.—At a meeting of the U.D.C. the Gas Committee presented a report, stating that they had engaged Mr. Wingfield Bowles, of Westminster, as consulting engineer, in regard to the proposed application to the B. of T. for a prov. order for the purposes of electric lighting. Mr. Bowles had made a survey of the town, and, as the result of his recommendations, it was decided:—(*a*) That the site of the generating station be at the wharf; (*b*) that the greater portion of the town be scheduled as the compulsory area, provision being made for extensions as may be required; (*c*) that the generating power shall be steam. Mr. Bowles was instructed to proceed with the requisite plans and estimates. It was decided that the Council should work the order themselves, and not hand it over to any outside body.

Dorking.—The E.L. Committee has approved the plan submitted by Messrs. Edmundson's, Ltd., for the electrical installation.

Dublin.—At the fortnightly meeting of the Lighting Committee, Mr. Robert Hammond attended, and reported that the change over from the old to the new system had, under the supervision of his assistant, Mr. Brew, been carried out successfully. The Committee had under consideration the question of the delay in connection with the completion of the public arc lamp contract. Arrangements were made with regard to the L.G.B. inquiry, and to the electric lighting supplemental loan for the city, and also the loan for Clontarf. The question of special rates for electrical supply to certain classes of consumers was also considered.

Eastleigh and Bishopstoke.—The U.D.C. has unanimously passed a resolution to take steps to obtain a prov. order for electric lighting.

Exeter.—Great progress has been made in the erection of the machinery at the new generating station, and the electrical engineer has every hope that it will be possible to raise steam on a portion of the new plant in four weeks' time, and to obtain an auxiliary supply by November 1st. It is, however, too late to arrange for the changing over of the entire supply to the new station, as at least one month would be occupied in arranging the various circuits to work properly on the two-phase supply. To overcome this difficulty the electrical engineer has arranged a special circuit to supply one section of the town in such a manner that its load can be carried by the new station for about six hours daily while the old station is working at its maximum, and this will enable the Council to go through the winter with ample power for all requirements. The electrical engineer reports that for the 15 months ending March 31st last, a profit of £2,360 has been made on the working of the electric light undertaking, after meeting the interest and sinking fund charges, and extremely heavy sums for rates and taxes (amounting to £600 a year). The accumulated "profits and reserve fund" now amount to nearly £6,000.

Felixstowe.—A L.G.B. inquiry has been held into the application of the U.D.C for a loan of £17,160 in connection with the electric lighting scheme. Representatives of the Gas Co, the Council, and a number of ratepayers attended in opposition. The present application was for £17,160, to extend over a period of 25 years. The Council obtained a prov. order for supplying electricity in 1900, which was extended for twelve months from July 31st, 1902. The Suffolk Electricity Supply Co, whose works it is now proposed to purchase under a special agreement, has no Parliamentary powers. Negotiations first took place between the Council and the company in 1900, but there was no development until 1902, when the Council applied for a clause in its Improvement Act to control the company's overhead wires. This clause was thrown out by the House of Lords Committee, and the purchase was decided upon. Since then the Council had obtained the sanction of the Board of Trade to the overhead wires continuing for a period of five years. The cost of lighting the promenade was provided for in the amount.

The inspector questioned whether the clause mentioned gave powers to borrow money for that purpose. The agreement dated May 18th, 1903, stated that the Council was to purchase the plants, works, machinery, &c.; that the company were to carry on the works for 25 years, the Council having the option of terminating the agreement at the end of 15 years; that the Council was to provide all moneys for capital expenditure; that the purchase money should be £8,000, £5,000 of which should be paid within three months of the Local Government Board's sanction to the loan, the other £3,000 to be retained by the Council until the company's balance-sheet in any one year showed a profit of 6 per cent. The Council was not purchasing the overhead wires, but had the use of them for 25 years. Complaints had been received as to the noise caused by the gas engines at the station, and mainly for that reason they were proposing to use steam power.

Mr. R. P. Wilson, the Council's consulting engineer, estimated the value of the plant and buildings at £6,500, without the land. The U.D.C. had decided on his recommendation to substitute steam for gas plant, but the company's consent had not yet been obtained. After a lengthy discussion the inquiry closed.

Glasgow.—The T.C. has authorised the Electricity Department to borrow £10,000 for capital purposes, making the total amount borrowed to date £1,127,000. The Electricity Committee, having remitted to a sub-committee to consider and report "as to the expediency of exercising the powers conferred on the Corporation by Section 19 of the Glasgow Corporation (Gas, &c.) Order, 1902, to provide, sell, let for hire, and fix up, alter, repair and remove motors and other fittings and apparatus for the supply of electrical energy for heating and motive power," have had a report presented to them by Mr. W. A. Chamen, their engineer. He states that many inquiries on the subject have, during the last two or three years, been made by various consumers, and on investigation he found that, up till now, there were 64 electric undertakers in the United Kingdom who had adopted the system of selling or hiring out such motors. In Glasgow, however, up to the present time, consumers had always purchased their own motors, and at May 31st of the present year some 1,059 motors had been connected to the mains, taking an aggregate of 4,597 H.P., in sizes varying from ½ H.P. to 70 H.P. The number of units consumed during the year by these motors was 1,560,509. In Bradford and other towns the demand for electricity had been increased by the hiring of motors to those who either could not afford, or did not care, to purchase them outright. In many cases the consumers had purchased the motors after hiring them for a time. It seemed that, generally speaking, the sizes of motors asked for were likely to be small ones, and it had been necessary in Bradford to lay down stringent rules as to payment of rent, &c., in advance. There was certainly a possibility of working up a new business in poor districts where motors might be required for various kinds of work which could be done in the people's own houses, but there were no such cases before them at present. The largest demand came from butchers, who required motors for chopping up meat for sausage-making. There would apparently be cases of other consumers of various kinds who wished to try electric driving experimentally before making any material outlay themselves. These would probably purchase the motors after finding the experiment satisfactory, and considerable expansion of the power supply might be induced in this way. It had often been suggested that hiring out of motors could and should be done by the electrical trade or by the motor manufacturers themselves, but private enterprise did not seem to succeed in that direction. Probably the rental required by any manufacturer or trader, in order to make the business pay, was too high for the intending consumer, and the trader could not afford to do the business without a profit, as there was no other indirect benefit to be obtained from it. In the case of the supply authority, however, the case was quite different, as a profit was made out of the sale of electricity consumed by the motors, and a rental which would cover interest, sinking fund, renewal and attendance was quite sufficient to justify the business. It was

generally found that 15 per cent. on the net cost of the motor and its accessories was sufficient for that purpose. That figure was arrived at as follows:—

Interest	3½ per cent.
Sinking fund	2½ „
Renewal fund	5 „
Attendance	4 „
	15 per cent.

The consumer, however, was required to put in the necessary wiring and the foundation for the motor at his own expense, as that could not be treated as a portable or movable subject. The actual delivery and fixing of the motor and the accessories which were hired out with it were carried out by the Corporation at a fixed charge, made in addition to the rent. In the event of the scheme being adopted, it would be necessary to select good makes of motors, and to have all those motors of any one size supplied by the same maker, so that the parts might be interchangeable for repair purposes. This was a point which might make all the difference between success or failure of the scheme. It was decided to proceed with a scheme on the lines of the report.

Mr. Chamen, electrical engineer to the Glasgow T.C., has been appointed arbitrator in the dispute which has arisen between Nobels Explosives Co., Ltd., and the electrical engineer who designed, and the contractors who fitted up, the company's electric lighting installation three years ago.

A special sub-committee of the T.C. has been appointed to consider and report as to the extension of plant required at the Port Dundas and Pollokshaws generating stations during the next two winters.

Another special sub-committee of the T.C. has been appointed to consider and report on an application by the T.C. of Rutherglen that the burgh be included within the Glasgow electricity supply area.

The T.C. is considering an application made by the Glasgow School Board for the electric lighting of all their schools.

Gravesend.—The electrical engineer submitted to the Council the following estimate of further sums required in connection with the electricity and dust destructor undertaking:—Drainage, £367; paving and fencing roadway, £310; tiling engine house, £160; building cable chamber, £35; boiler house extras, £60; wages of clerk of works and watchman, £130; coal conveying plant, £300; trucks and rails for same, £90; pipe covering extras, £30; lengthening connections to economiser, £50; 100-kw. generating set, connections, condensers, pipes and erection, £1,250; fan, £40; additional pipes to condensers and lime treatment plant, £500; allow for larger size of lime treatment plant, £150; circulating water pipes, £300; testing instruments and additions to switchboard, £150; main extensions, £420; further house service connections and meters, £200; telephones, £50; extra cost of bye-pass for dust destructor, £52 15s.; contingencies, £455 5s.—total, £5,100. The estimate was passed, and the town clerk was directed to take steps to obtain a loan for the amount.

Greenock.—The success which has attended the electric lighting of the main streets has induced the Council to propose the lighting of the small streets with Luna Nernst lamps by way of experiment.

Hamilton.—The electrical street lighting has been formally inaugurated, that for houses and shops having been in operation for some time. Edmundson's Electricity Co., Ltd., invited the Provost, Magistrates and Town Council and others to assist at the inauguration in the Council Chambers. Mr. T. M. Colson, the resident engineer, presided, and Provost Keith switched on the new lights for the leading streets. The lamps are 65 in number and of Bremer pattern.

Hastings.—On Friday a L.G.B. inquiry was held relative to the application of the T.C. for a loan of £250 for E.L. purposes. There was no opposition.

Hythe.—The Electric Light Co. has taken over the whole of the lighting of the borough.

Ilford.—As an experiment the U.D.C. has decided to erect four 10-ampere arc lamps in the Broadway, and to make a trial with Nernst lamps.

Italy.—A company has just been formed in Milan with a capital of £20,000, to be known as La Società per le Forze Motrice dell'Aura, to put down plant to utilise certain available water power.

Linthwaite.—The U.D.C. has sealed an agreement with Huddersfield T.C. for the supply of electricity at the Milnsbridge end of the town.

London.—Battersea.—The B.C. has ordered the seal to be affixed to an agreement with the Rhodes Electrical Co., Ltd., whereby the company will supply to consumers motors on the "hire," "hire-purchase," and "direct-payment" systems. A scheme, prepared by the consulting engineers in conference with the electrical engineer for the provision of plant for raising coal from barges and conveying it to the central electric generating station, was approved. The estimated cost is £3,500.

Marylebone.—A petition has been prepared for presentation to the Local Government Board, asking that consent be withheld from the acquisition by the B.C. of the local undertaking of the Metropolitan Electric Supply Co., as required by the arbitration award, until a full investigation has been made into an allegation that "certain members of the Corporation and the late vestry used the knowledge acquired in their respective offices for the purpose of facilitating speculative dealings in shares of the Metropolitan Electric Supply Co."

Hammersmith.—Upon the recommendation of the Electricity Committee it was resolved to order an installation of Howden's forced draught apparatus for No. 1 boiler. The electrical engineer stated that the saving of fuel would recoup the cost, £355, in about 12 months. In their case, however, the actual saving in this way was a secondary consideration in comparison with the necessity of having a stand-by plant for the winter months. Formal permission was received from the Thames Conservators for laying in the river bed the suction pipes required in connection with the extension of the condensing scheme. It was decided to purchase two transformers at £350 each, and to charge two firms an annual rental at the rate of 5 per cent. of the cost.

Luton.—The T.C. has adopted a recommendation that the offer of a private firm to hire out motors on the Corporation's supply should be accepted. Some 24 motors are at present on the mains.

Macclesfield.—The Electricity Committee of the Macclesfield Corporation, at a meeting on September 24th, discussed at considerable length three schemes which had been submitted to it for an electric light installation for the borough. These were the schemes of the British Westinghouse Co.; J. & J. S. Enright, Westminster; and Messrs. Crompton & Co, Ltd., London, whose estimates were, £32,300, £26,000 and £15,577. On a division it was decided to recommend the Town Council to accept the principle of Messrs. Crompton & Co.'s scheme, provided such modifications are made as will meet with the full requirements of the Corporation. Under this scheme the contractors undertake to supply and erect the whole of the plant and mains, to run the undertaking for a period of three years, and to pay the Corporation 6 per cent. per annum on the capital outlay, and estimate an annual profit at the end of three years of £1,687.

Maidstone.—The Electricity Committee has recommended that a flat rate of 4½d. per unit be charged for the lighting of all public buildings, and premises where residences and shops are combined, and that the Committee be empowered to spend £500 for purchasing motors to be let out on hire.

Newton.—The Lighting Committee reported having considered the application made by the Urban Electric Supply Co., Ltd., for permission to lay their cables to Kingsteignton. While not wishing to stand in the way of Kingsteignton, they considered the Council should adhere to the advice given by the clerk, that such permission could not legally be granted by the Council.

Ossett.—The U.D.C. has declined an offer made by a syndicate to purchase the Council's E.L. Order, it being the intention of the Council to put the order into force.

Saffron Walden.—The committee appointed to consider the question of introducing electric lighting into the borough, reported in its favour, adding that the Council would utilise the power at the water works; it was also recommended that an application be made to the B. of T. in November for a prov. order to supply electrical energy in the borough. The report was adopted.

Southgate.—The U.D.C. has unanimously agreed to apply to the B. of T. for a provisional order authorising the selling of electrical energy for public and private purposes.

Stretford.—The electricity generating station, built by the District Council on the main road at Longford Bridge, Gorse Hill, has been completed, and will be opened in the course of the next fortnight. The new station is of red brick. Mr. C. H. Wordingham is the consulting engineer, but in view of the appointment he has received under the Admiralty, the Electricity Committee is considering the advisability of appointing an engineer to take charge of the station.

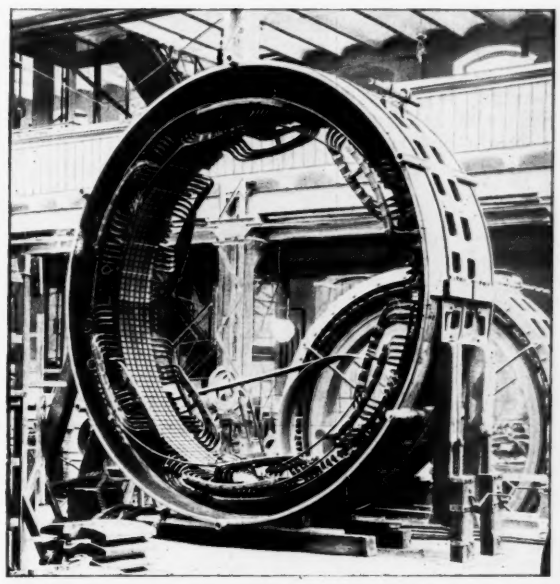
Tottenham.—A special meeting of the U.D.C. has been held to further consider the report of the Electricity Committee as to the laying of distributing mains and estimates of the cost of the necessary works, prepared by Mr. W. C. C. Hawtayne and Mr. W. H. Prescott. The order gives power to supply the whole of the district. About 129 arc lamps would be placed on the new electric tramway columns in Green Lanes, West Green Road, and other thoroughfares. The estimated cost of the undertaking was £96,500. The income was estimated at £17,356, less £8,358 for working expenses, the net result being:—Estimated gross profit, £8,998, less £5,790 for repayment at 6 per cent. on loan of £96,500, leaving a net profit of £3,208. A modified report was also presented, giving the cost at £69,540, and the profit at £6,027, gross; net, £1,827. This scheme reduced the number of streets—part of St. Ann's Road, all Woodland Park Road, Harringay Road, and other thoroughfares being struck out. The report was discussed at some length at the last meeting, and it was eventually decided to adjourn the meeting until last night, when a meeting of the Council in committee was to be held to discuss the matter with a representative of the North London Electric Light and Power Co., as the company had offered to supply electricity in bulk for distribution.

(*Continued on page* 547.)

THE VALTELLINA ELECTRIC RAILWAY.

Probably there was no feature of the Italian tour of the Institution of Electrical Engineers which made a deeper impression upon the members' memories than the subject of the first visit—the railway connecting the towns of Lecco, Sondrio and Chiavenna. Although this was not the first railway to be operated by three-phase induction motors, it was and is the only railway in commercial operation, on which a pressure of 3,000 volts is utilised on the overhead conductors and in the motors themselves. The system has now been in operation for just one year, and has by its successful working justified the enterprise and proved the ability of the engineers by whom it was carried out. The outcome of this bold experiment has been to show that there is no technical impediment to the propulsion of heavy trains with electricity supplied to the motors at high pressure, on a commercial scale, and to pave the way for the extension of electric railway working over long lines.

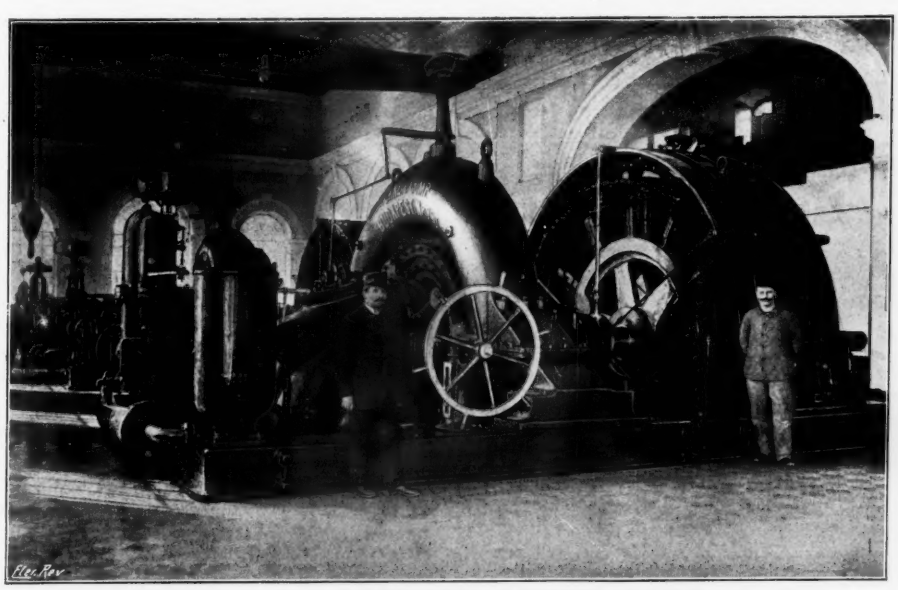
The railway, which forms part of the Adriatic railway system, was originally worked with steam engines, and carried a considerable goods traffic, while, in the summer season, there was also a large passenger traffic to be handled. A peculiar feature of the line is the large proportion of tunnel, mostly cut in the solid rock; between Lecco and Colico, the central point of the system, more than one-third of the route is underground, and half of it is curved, so that the difficulties in the way of electric traction, with overhead conductors at high pressure, were obviously very serious. The whole of the hydraulic, mechanical and electrical engineering works were entrusted by the railway company to the Society for Electric Traction on Railways, of Rome, with the exception of matters relating purely to the safe working of the railways, which the company retained in its own hands. The contractors carried out the hydraulic works themselves, and sub-contracted with the Schuckert Co., of Nuremberg, for the supply of the electrical generating plant, while Messrs. Ganz & Co., of Buda-Pesth, who were associated with the contracting company, supplied and erected the turbines, and the whole of the overhead material, transformers and new rolling stock. The length of the three sections at present electrified, which all radiate from Colico, is 67 miles. Many of the curves, which are very numerous, are of only 1,000 ft. radius, and frequent grades are met with, the heaviest being 22 per 1,000, on a sharp curve. The stations



1,500-kw. 20,000-Volt Schuckert Three-phase Armature.

are, on the average, 3 miles apart, while express trains stop at intervals averaging 8½ miles; the average time interval between successive trains is 1 hr. 40 mins. The population of the district served amounts to only 200,000 residents.

The tracks are of British standard gauge, laid with 55 and 71 lb. rails, and single track throughout. The schedule speed of express trains, including stoppages, is 26 miles per hour, rising to 40 miles per hour between stops; the local trains average 20 miles per hour.

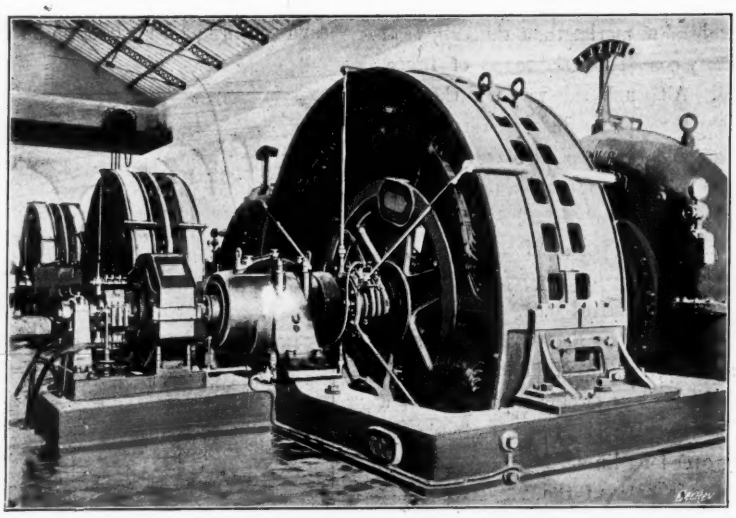


Interior of Generating Station

Thanks to the satisfactory working of the sections already equipped, the conversion to electrical working of further sections, connecting Lecco with Milan and Como, and com-

prising 57 miles of route, has been sanctioned. These routes also will be worked from the existing power station, which is at present underloaded.

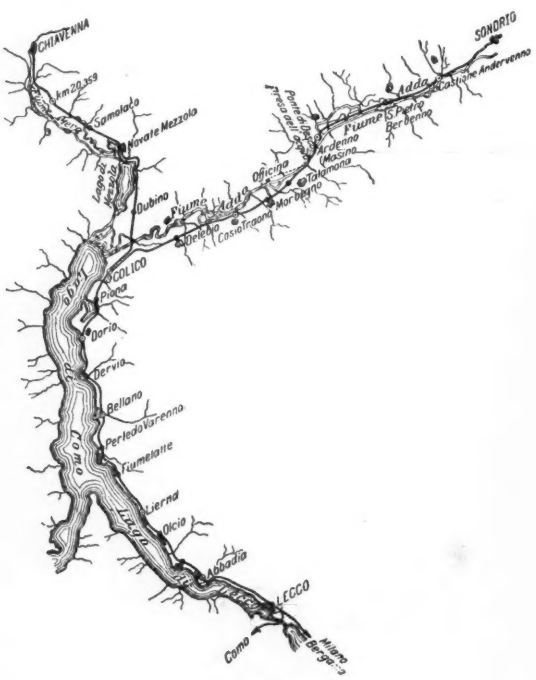
The electrical system consists, briefly, in generating three-phase currents at 20,000 volts and distributing them to sub-stations, where the pressure is reduced to 3,000 volts for supply to the overhead conductors. The motors are of the three-phase induction type, arranged in pairs on the Ganz cascade system. Motor-cars are used for hauling the passenger trains and locomotives for goods traffic; power is collected from the overhead lines by means of rollers.



1,500-kw. Three-phase Schuckert Alternator and Ganz Turbine.

Water power is derived from the river Adda, and is brought from the headworks by a canal three miles in length, mostly in tunnel through solid rock, to the power station at Morbegno. The minimum supply of water is equivalent to a total of over 9,000 h.p., and as this occurs in the winter, while the maximum load and the maximum water supply occur in the summer, it will be seen that Nature has arranged matters to the best advantage for the purpose to be fulfilled. The available head is 100 ft.

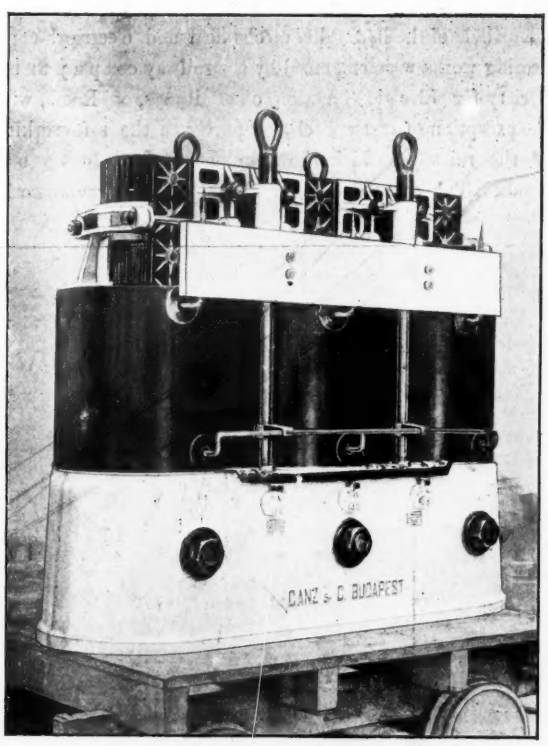
From a settling basin in the mouth of the tunnel the water enters two riveted steel tubes, each 8½ ft. in diameter and 234 ft. long, which convey it to the turbines. The latter are housed in a building measuring 170 ft. × 72 ft. × 50 ft. high, erected on the right bank of the Adda, into which the tail-race discharges.



Map of Routes.

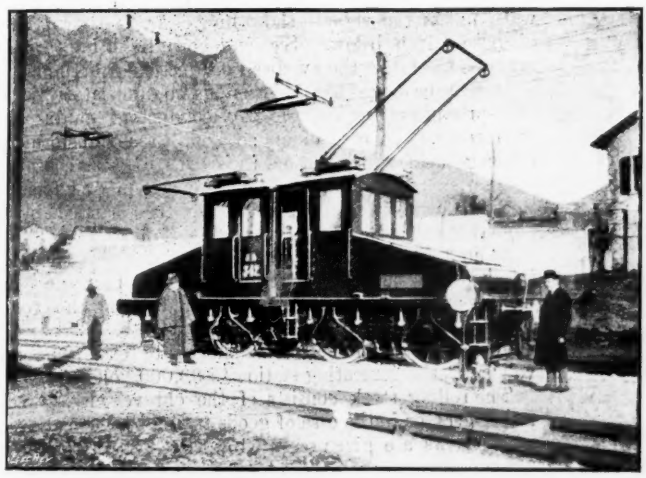
The generating plant at present installed comprises three sets, each of 2,000 h.p.; space is provided for an additional set of 4,000 h.p. The flumes divide in the power station, each supplying two turbines. The latter are all of the Francis inward-flow type, made by Messrs. Ganz & Co., and are provided with adjustable guide blades controlled by centrifugal governors acting on hydraulic oil relays; the guide blades can also be adjusted by hand, and the speed can be controlled from the main switchboard platform. The water is admitted through a butterfly valve, and after passing through the turbine escapes by a draft tube 22 ft. long. An indicator mounted on the top of the turbine casing, and connected with the governing mechanism, shows roughly the load on the turbine at any moment.

The alternator is of the fly-wheel magnet type, the magnet wheel being mounted with the turbine wheel on a common shaft carried in two main bearings; the latter are 12 in. in diameter, and 8 ft. 2 in. long over all. The exciter armature is coupled to the end of the main shaft. The field magnet has 12 poles, giving, at 150 r.p.m., a frequency of 15 cycles per second, and weighs 44 tons. The armature frame is 16½ ft. in diameter over all, and weighs 26 tons; it is unusually wide axially, and is stiffened with radial rods to rings on the main bearings. On account of the high voltage great care has been taken to secure high insulation in the armature windings, which consist of formed coils of cotton-covered wire laid in thick micanite tubes; there are 16 grooves in the armature core, of which, however, 24 (two per pole) are empty. The alternators are rated at 1,500 kw. each, with a power factor of 70 per cent., and are capable of enduring a short-circuit of two minutes' duration, during which the current attains a value six times the normal. On a non-

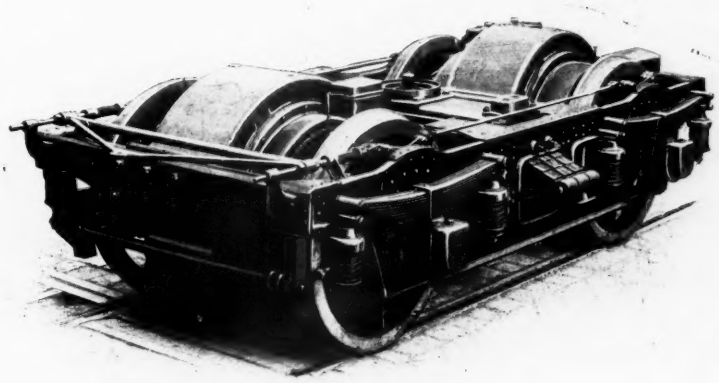


300-kw. Sub-station Transformer.

inductive load the output would be 1,500 KW. It is claimed that these machines are the first in which so high a voltage has been generated direct on a practical scale. They will bear an overload of 30 per cent. without injury, and the temperature rise above the surrounding atmosphere at normal load does not exceed 45° C. The exciters work at 50 volts, 300 to 450 amperes. A small centrifugal governor is provided, which inserts an extra resistance in the field magnet circuit of the exciter in the event of the speed of rotation attaining an excessive value, so as to prevent the alternators from generating too high a voltage and damaging the switchgear. The maximum pressure which can be attained is thus limited to 25,000 volts. The fall of pressure between light load and full load is not more than 15 per cent., and when the full load is thrown off the pressure rises only about 10 per cent.



ELECTRIC LOCOMOTIVE.



MOTOR TRUCK.

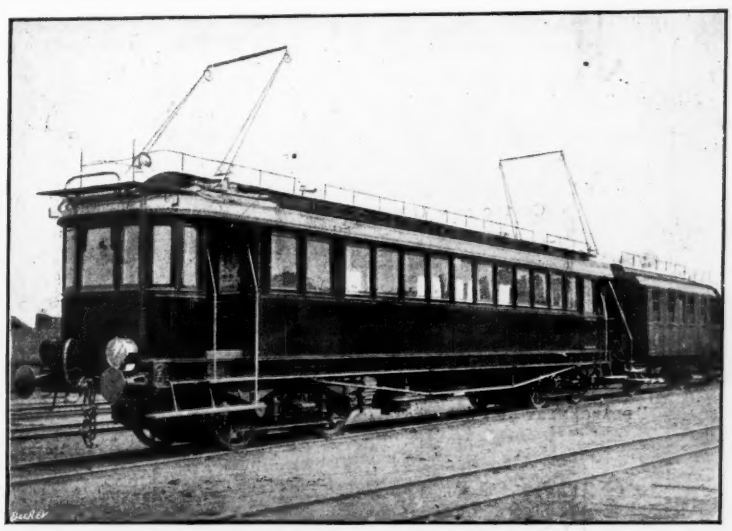
The operating switchboard is placed in a recess off the generator room, and consists of six marble panels, of which five are in use. All the apparatus on this board is of low pressure and safe to handle. Behind the board, in a large room, is the switchgear proper; this is arranged on the framework principle which is so popular on the Continent, and occupies a considerable space, both vertically and horizontally. There are two sets of main bus-bars, each equipped with three ammeters, a voltmeter, and a watt-hour meter; each alternator is provided with two three-pole switches for coupling up to either set of bus-bars.

All the switches are placed at a height of 20 ft. from the ground level, and are operated by rope gear from the main switchboard. The generators are provided with one ammeter, voltmeter and synchronising voltmeter each, and the exciters with an ammeter, rheostat and switch. The fuses are enclosed in porcelain tubes wrapped with paper, and are fixed in separate marble compartments. Lightning arresters are provided, and, in addition, there is a water-jet earthing device fixed on the overhead lines outside the station; this consists of an earthed vertical pipe through which a jet of water is forced upwards into an umbrella-shaped vessel in connection with each conductor. The leakage current through these jets amounts to only 0·1 ampere, and the device, which is only used on the approach of thunder-storms, has effectually solved the problem of ensuring against lightning discharges, which at first gave serious trouble.

The high-pressure lines for the railway consist of three bare copper wires, spaced 24 in. apart, and carried with porcelain insulators on larch poles by the side of the track. The conductors running towards Sondrio are 7 mm., and those running to Colico 8 mm. in diameter; at Colico the line divides into two sets of 7 mm. wires running to Lecco and Chiavenna. Generally the high-pressure wires are carried on the poles which support the trolley wires, but they branch off at tunnels and are carried overground. The high-pressure insulators are five-lipped, in three pieces, and are tested to 60,000 volts.

There are in all nine transforming sub-stations, each of which contains, as a rule, one 300-KW. three-phase air-cooled transformer, together with the necessary switchgear. At each of these sub-stations high-pressure switches are provided for dividing the primary conductors into sections.

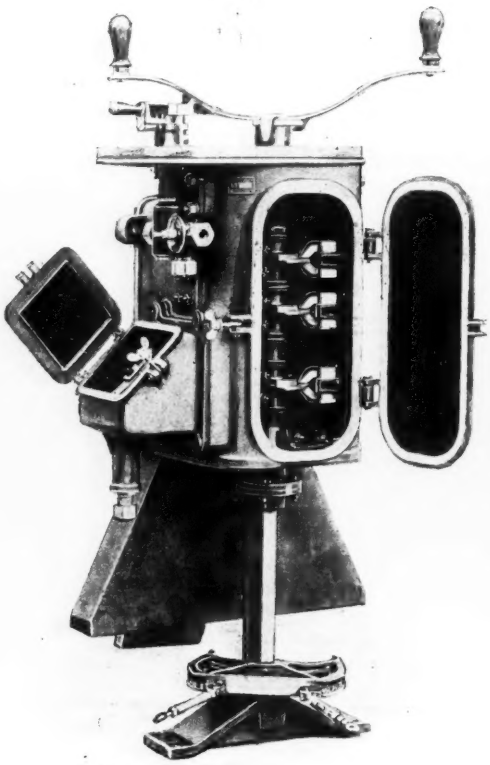
The conductors which supply the current to the trains comprise two overhead hard-drawn 8-mm. copper wires, 3 ft. apart,



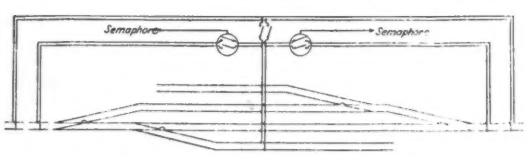
MOTOR-CAR.

and the bonded rails. The wires are suspended at a height of 20 ft. in the open, 16 ft. in tunnels, from ambroin insulators of the type illustrated overleaf, carried by separate galvanised steel span-wires; the latter are supported by side poles on curves up to 3,000 ft. radius, and by single or

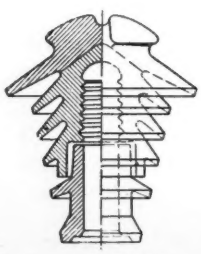
Safety Device on Air Valve.



Controller, Open.



Arrangement of Conductors at Station.



Insulator for Primary Conductors.

Span Wire Insulator.

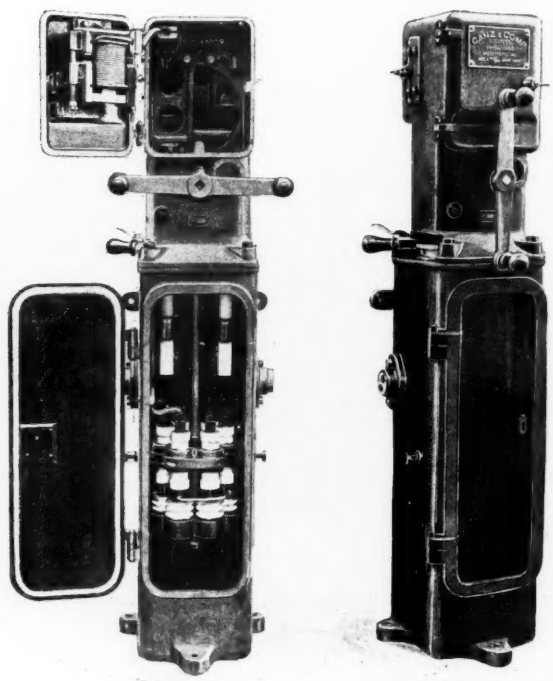
double brackets on poles where the line is less curved, and in stations. By way of precaution, the overhead wires for a length of 1,050 ft. each way from a station are isolated by section insulators, and cannot be connected with the live wires unless the signals show line clear, as shown in the diagram given below. Siemens horn lightning arresters are used to protect the overhead conductors of both classes.

It will be observed that there is no duplicate system of high-pressure mains, a single set of conductors running along each route. In case of an accident to a transformer or other gear in a sub-station, the latter can be completely disconnected from the high pressure system and from the working conductors, the load being then carried by the adjoining sub-stations on either side.

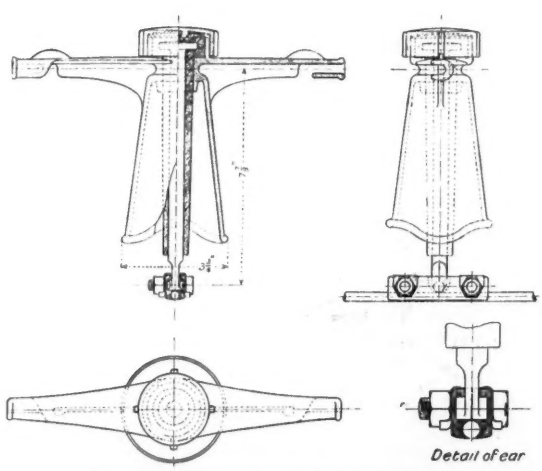
At junctions and crossings the simple device is adopted of interrupting one of the overhead wires, so that the trolley makes contact only with the other, and during the crossing the motors function as single-phase machines.

The insulation of the whole system is tested by raising the voltage at the generating station to 30,000 volts.

The rolling stock consists of the old vehicles, towed by motor-cars, or in the case of goods trains, by locomotives, of which views are given on p. 545. Each of the motor-cars



Main Switch, Open and Closed.



Ambroin Insulator and Swivelling Ear.

weighs 53 tons, and hauls five coaches, the aggregate weight of the train being 150 tons. The car is 64 ft. in length over all, and is equipped with four motors, arranged in two

pairs on the cascade principle, so as to give two normal speeds. A short *résumé* of this system may be useful to those who are unacquainted with it or whose memories are "rusty." The main motor is always used with its stator coupled direct to the 3,000-volt conductors; the rotor of this motor is wound for a maximum pressure of about 300 volts, and is connected with the stator of the other motor, when accelerating up to or running at half-speed, and when retarding from full speed. The rotor of the second motor is connected with a non-inductive liquid rheostat, controlled by air pressure. At starting, the maximum resistance is inserted in this rotor circuit; it is automatically cut out as the speed increases, until at half-speed the resistance is short-circuited, the two motors then running in "cascade." Above half-speed, the second motor is cut out of circuit altogether, running idle, while the rotor of the first motor is coupled to the rheostat; the resistance is then automatically cut out by degrees until full-speed is reached. In order to economise energy, the system is also used in braking from full speed to half speed, by connecting the motors in cascade, when, as they are running above the synchronous speed for this connection, they return current to the line. As the energy given out in slowing from full to half speed is three-quarters of the kinetic energy of the train at full speed, a considerable economy can thus be effected. Below half speed, the Westinghouse air-brake is used.

The connections above described are made by means of a special, but very simple, controller, which we illustrate on p. 546. The main handle-bar has only three positions—low speed, off, high speed; alongside it is a regulator handle controlling the air-cock which operates the liquid resistances. The latter cannot be moved when the controller is "off," while the controller in turn cannot be put "off" when the regulator is open. In starting, the main lever is set to "low speed," and the air-cock opened, the rate of acceleration depending upon the position of the latter. If full speed is desired, after half speed has been attained, the air-cock is shut, and the controller put to "high speed," cutting out the second motor and connecting the rotor of the first motor to a rheostat; the air-cock is then opened, and the speed automatically rises. It should be mentioned that when the air-cock is shut, the primary current is by the same action cut off.

A main three-pole primary switch, shown in one of our views, is fixed in the driver's cab, and is operated either automatically, as above mentioned, or by hand. It is of the plug type, with six contacts, giving a break of 16 in. The plugs slide in porcelain tubes, and have given satisfaction in use. The main switch serves also as a reversing switch, the plugs being moved round through an angle of 120°, by a handle at the side of the case, when the circuit is broken.

To prevent the driver or other official from obtaining access to the switchgear when it is alive, the switchbox is locked, and the key is placed in a valve connected with the air-cylinder by which the trolley is raised; it cannot be removed from thence unless the trolley is down, and the latter cannot be raised unless the key is in the valve. Moreover, lest the driver should unlock the switchbox and leave it open, the key cannot be withdrawn from the lock unless the door is closed.

Current is collected from the overhead conductors by two contact rollers, which are carried on a wooden axle 65 in. long, with an insulating separator 9 in. long between them. The rollers are cylinders of electrolytic copper, 26 in. long and 3¼ in. in diameter, and run on ball bearings. The currents are collected from the rollers by carbon blocks, and are carried down by insulated cables inside the trolley arms to the main switch. The trolley base is insulated from the car roof by porcelain insulators. The arms of the trolley are of Mannesmann steel tube, 9 ft. 9 in. long. The trolley is raised and lowered by an air cylinder acting through springs, with a glycerine buffer dash-pot to control the motion.

(*To be concluded.*)

Whitehead Lighting.—At a meeting of the Ratepayers' Association it was stated that all arrangements had been completed with the National Electrical Wiring Co. for lighting the village; 27 public lamps would be installed, and the undertaking would be completed in the course of a few months.

ELECTRIC LIGHT AND POWER NOTES.

(*Continued from page* 542.)

Tiverton.—Messrs. F. Suter & Co., of London, have made an offer to the T.C. to carry on the electric light undertaking entirely at their own risk, paying all expenses, including interest and sinking fund on the capital expenditure, for three years from the date of the completion of the work, in consideration of a payment of £500 over and above their contract price.

Wolverhampton.—The new infirmary and workhouse was formally opened on the 24th ult. The buildings afford accommodation for 1,400 inmates, and are distributed over an area of 50 acres. An electric lighting plant consisting of two Belliss-E.C.C. combined sets, each capable of giving 66 KW. at 205 volts, is provided; the engines exhausting into the heating system. A battery of Chloride cells is provided with a discharge rate of 9 KW. for 9 hours, and an E.C.C. booster for charging it. There are about 2,200 lights fixed, and the feeding points are connected by B.I.W. lead-sheathed cable laid along the pipe trunks. The whole installation has been carried out by Messrs. Woods, Slacke & Co., of Blackburn, who have also supplied a complete system of telephones, watchman's tell-tales and bells. The work has been carried out to the specifications and plans of Mr. David Stevenson, Westminster.

Woolwich.—It was reported at the last meeting of the B.C. that the accounts of the electricity undertaking were very much in arrear, and that it would take the clerks, working overtime, eight weeks to get them up to date.

Wrexham.—At a meeting of the T.C. the Electricity Committee submitted a scheme for extending the electric cables for public and private lighting. All the principal thoroughfares in the borough are included, and it is proposed to supersede 117 ordinary gas lamps and 10 "Bray's" with 41 arc lamps and eight Nernst lamps. The candle-power of the two lights was 2,372 and and 83,615 respectively. The total cost of the gas light was £752 15s. per annum, while the improved lighting by electricity would cost £932 10s. It was, however, pointed out that the extension of the cables would result in a large increase of private consumers, and that a much larger production of electricity could be made without additional cost. The Council approved the scheme, and directed the electrical engineer to prepare a statement of approximate cost.

Yorkshire Electric Power Co.—The contractors are now in possession of the land for the first power station at Thornhill, and the erection of the buildings is being rapidly pushed on. Tenders have been accepted for a 6,000-H.P. generating plant. The generators are to be driven by Curtis steam turbines, the whole being supplied by the British Thomson-Houston works at Rugby. The company, it is stated, are now in a position to negotiate for the supply of power within a radius of 10 miles of the first station, and power will be available in about 10 months' time.

ELECTRIC TRACTION NOTES.

Altrincham.—Many tradespeople in Altrincham are, rather short-sightedly, opposing a scheme for bringing the Manchester electric trams into the town. They say that the district will be deprived of many of its beauties by the erection of traction poles, and that most of the wealthier residents will leave. The objection is considered baseless by a majority of the inhabitants, who decided at a public meeting last week in favour of trams. A poll is to be taken.

Belfast.—At a special private meeting of the Law Committee of the Corporation on the 28th ult., the question of the purchase of the tramway system was again discussed. It is understood that the Corporation has another project for the acquisition of the lines, which, together with the change and electrification of the system, and the compensation of directors and chief employés, would cost roughly about £660,000. This scheme has been prepared to back up the Bill for compulsory purchase in the coming session of Parliament.

Berlin.—The Prussian State Railways Administration have decided to run all trains on the suburban railway between Berlin and Lichterfelde by electric power. Each train will consist of two long cars of different classes, with separate compartments for smokers. It is expected that electricity will soon oust steam from all the suburban lines of Berlin.

Bexley.—The new electric tramway from Plumstead to Bexley was last week examined by the B. of T. officials. The opening ceremony of the electric lighting and tramway system took place yesterday.

Heywood.—The T.C. has decided to give notice to the Bury, Rochdale, and Oldham Steam Tramway Co. to sell the tramways belonging to them in the Heywood borough to the Corporation. It is proposed to convert the system to electrical working when municipalised.

Heywood and Manchester.—The Electricity and Tramways Committee of the Heywood Corporation are endeavouring to arrange with Manchester for the running of Manchester Corporation electric trams through Middleton to the Market Place in Heywood.

London.—Lewisham.—The B.C. has resolved to offer £30,000 to the L.C.C., being one-sixth of the cost of the street wideniogs required in connection with the proposed tramways from New Cross to Lee Green, Greenwich to Catford, Lordship Lane to Forest Hill, Lewisham High Road to Forest Hill. The L.C.C. asked for a contribution of one-third.

South London.—Messrs. J. G. White & Co., of College Hill, E.C., contractors for laying the L.C.C.'s electric tramway in South London, have practically completed their contract. Tooting to the Bridges, single track, 1·6 miles, was commenced April 1st, 1902, and finished May 1st, 1903; Camberwell Green to Vauxhall, 4·2 miles, was commenced February 3rd, 1903, and finished June 18th; New Cross and Old Kent Road, 9·6 miles, was commenced April 1st, 1903, and finished August 31st. 16,675 tons of iron were used, made up as follows:—Rails, 9,500 tons; special work, 1,175 tons; other iron, 6,000 tons. 7,200 tons of cement were used, and 18,500 stone setts. The maximum number of men employed on the job was 1,100, the average number daily employed was 800. The superintendent engineer was Mr. J. H. Fisher; and the assistant engineers were Messrs. C. Wood, G. F. Perry, and W. C. Butler. The materials chiefly used were British.

Macclesfield.—A private company will seek power from Parliament next session to construct tramways which will connect the town of Macclesfield with other populous districts of Cheshire.

Manchester.—The promoters of the West Manchester Light Railway proposed to construct a light railway from Trafford Park to Irlam Ferry on the Ship Canal, mainly for the accommodation of the workmen employed at the Westinghouse and other establishments. The scheme, however, has met with so much opposition from the local authorities that it is to be abandoned in favour of one less open to objection, from Stretford to Davyhulme, *viâ* Lostock Road.

Middlesex.—The work of relaying the metals of the old horse system in the eastern part of the county is approaching completion, while the Great North Road system has been partially laid from the Whetstone boundary to Finchley. The Friern Barnet U.D.C. has deferred the consideration of plans for electric cable laying in Friern Barnet Road submitted by the North Metropolitan Electric Power Co.

Perth.—At a special meeting of the T.C. on Monday, it was agreed, after a long discussion, to appoint a committee to carry out the reconstruction of the Corporation's tramway undertaking within and without the burgh, from horse to electric traction.

Preston.—A sub-committee has spent considerable time endeavouring to find out the type of car most suitable for the requirements of the town. The smaller car, which was recommended for acceptance, would accommodate 20 people inside and 28 out, and the larger one would carry between 70 and 80 passengers. The committee recommended that tenders for 25 single-truck cars with the ordinary staircase be invited, The Council has approved this recommendation. It has also decided that there should be no lines of centre street poles.

Spain.—A project is at present under the consideration of the Xérès Municipal Council in regard to the concession for a period of 25 years of an electric automobile service for the transport of goods and passengers. The concessionnaire will be given a monopoly for the period mentioned.

Tyneside.—On the 27th ult. some trials were carried out on the North-Eastern Railway near Wallsend in connection with the electrification of that section of the system. The scheme has been under consideration for a long time, and is intended to compete with the tramways which cover most of the ground that is to be served by the electric trains. For long distances the trains will have an immense advantage over the urban trams in point of speed, and will, therefore, it is anticipated, enable the company to hold their own, which they can scarcely be said to have done for some time past, as it is stated that the receipts on the Tynemouth line, which is included in the development, dropped by £7,000, in six months. The trial on Sunday was made between Carville station and Percy Main junction, a distance of 3 miles. On this section the work of change has been completed, the third rail having been laid, and the electrical connections made. The train with which the tests were made consisted of two motor-cars and a trailer, and was brought up from York for the purpose. The trials are said to have been entirely satisfactory; the cars showed themselves capable of maintaining a speed of 45 miles an hour; the power of acceleration was such that the train attained a speed of 30 m.p.h. within 35 seconds of starting from rest. Energy was drawn from the Neptune Bank power station of the Newcastle-on-Tyne Electric Supply Co., the Carville works not being sufficiently advanced. The electrical equipment of the motor-coaches and trailers, the laying of the third-rail and low-pressure feeders is being carried out by the British Thomson-Houston Co., Ltd.; the switchboards, transformers, converters, &c., are being supplied by the British Westinghouse Electric and Manufacturing Co., Ltd. About 37 miles of route remain to be adapted for the new mode of traction. It is as yet quite uncertain when the work will be completed.

Wigan.—On Monday representatives of the Wigan Electric Tramways Co. and of the Law and Parliamentary Committee of the Ince District Council met to consider matters affecting the tramways in the township of Ince. An arrangement was come to by which the representatives of the Ince District Council undertook to grant a lease to the company for 21 years, of the lines in the township of Ince, on the Wigan Corporation undertaking to adopt the broad gauge and equip the tramways electrically.

TELEGRAPH AND TELEPHONE NOTES.

London Telephones.—At a meeting of the City Guardians this week, the Assessment Committee was authorised to appoint a competent person to assist in valuing the wires, transforming stations, and appurtenances of the Post Office telephone system throughout the City. Mr. Walter Barnett, of Winchester House, was appointed at a fee of £63.

Portsmouth.—Mr. H. Percy Boulnois, M.I.C.E., Local Government inspector, last week held an inquiry into an application by the Portsmouth T.C. for leave to borrow £12,000 for the purposes of the municipal telephone system for Portsmouth and the urban, rural, and parish districts in which it is in use. The town clerk explained that originally the scheme propounded was for 1,240 working lines, and that number had been put into operation. Since then these lines had been found insufficient, and it was proposed to extend the system so as to provide for the increased demand. At present, there were 1,346 instruments in use, and there were in addition 78 orders in hand. The present instalments had been carried out within the estimate originally given. A loan of £25,500 was sanctioned, and the expenditure reached £26,540. The excess was accounted for by some items such as increased work underground, to provide more cables than were originally estimated for. Another item which caused part of the excess was for an increased number of instruments obtained, which were now in use. There were also two items for building and preliminary expenses, which were not estimated for originally. Mr. W. R. Bennett, engineer to the Corporation, stated that the extension covered by the loan would comprise an addition of 760 lines to the number originally sanctioned. The capacity of the exchange would be raised to 2,000 within the telephone area. His original estimate was £26,580, but the L.G.B. would only sanction £25,500.—Mr. E. G. Robb, solicitor, of Tunbridge Wells, who appeared to oppose, cross-examined Mr. Bennett with the view of showing that the Corporation had not carried out the original estimates. He submitted that the method of working adopted was obsolete and relatively inefficient; that it was not up to the standard adopted by the Post Office, or by any large town, save those under Mr. Bennett's control, and that to spend further money on such a system would simply be to perpetuate an original mistake. A scheme involving the expenditure of this further sum of money was both technically and financially unsound. The estimate, Mr. Robb further contended, was delusive, in that, among other things, it made no adequate provision for surplus plant or inevitable expansion, and it ignored the effect of a keen competition. The Corporation were engaged in a war of rates with the National Telephone Co., and though this was to the benefit of the telephone user, it was to the detriment of the ratepayers, whose money was involved.—Mr. Bennett, in further cross-examination, admitted that a certain amount had already been spent of the £12,000 now asked for. He admitted that a duct was being laid. It transpired that it was only 8 in. below the surface of the road, whereupon the inspector remarked that the depth was insufficient, and he was sure that if the L.G.B. had the power to object they would do so.—It further appeared that certain balances had been used for the telephone business, and that nothing had been paid for these by way of interest.—The inspector said the matter would certainly have to be laid before the L.G.B.—Mr. Bennett, further cross-examined, said the Portsmouth scheme was a wise and prudent one. They did not want to jump a long way in advance, and he believed the system was a much better one than the National.—At the close of the inquiry, the inspector intimated that he would make his report to the L.G.B. in due course.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara No. 1	Aug. 27, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Guadeloupe-Martinique	May 7, 1902	
Puerto Plata-Martinique	July 10, 1902	
Anjer-Kalianda	Aug. 2, 1902	
Cayenne-Pinheiros	Aug. 13, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Paramaribo-Cayenne	Feb. 27, 1903	
New York-Haiti	April 13, 1903	
Bolama-Bissao	Aug. 4, 1903	
Antigua-Guadeloupe	Aug. 11, 1903	Sept. 25
St. Jacques-Haiphong	Sept. 28, 1903	

Telephone Assessments.—Edinburgh Valuation Appeal Court on 23rd ult. heard evidence regarding the National Telephone Co.'s appeal against the Assessor's valuation of their wires and wayleaves in the city. It was stated for the Telephone Co. that the gross revenue was £23,832, but the net revenue was only £4,106. The Assessor said he made the income of the company from sub-

scribers to be £33,500, and after deductions he thought they should be assessed at £8,788. The Court fixed the valuation at £6,000. The Telephone Co. asked that a case might be stated for an appeal. The valuation last year was £2,000.

Telephonic Communication with Belgium.—The Secretary of the General Post Office last week made the following announcement:—"On October 1st the existing telephone service between London and Brussels will be extended, and communication can be obtained by subscribers to the Post Office telephone system between the Central, Western, Victoria, and Putney exchanges in London and Antwerp, Bruges, Charleroi, Ghent, Liège, Louvain, Malines, Mons, Namur, Ostend, Termonde, and Verviers. Communication will, at the same time, be opened between Birmingham, Brighton, Bristol, Cambridge, Cardiff, Derby, Ipswich, Leicester, Lowestoft, Newport (Mon.), Norwich, Nottingham, Sheffield, Southampton, and Yarmouth, on the one hand, and Brussels and certain of the above-mentioned Belgian towns on the other. Particulars as to the extent of the service can be obtained from the local postmasters or from the secretary, General Post Office, E.C. In all cases the charge will be 8s. for a conversation of three minutes."

West African Telegraphs.—It is stated that the telegraph line between Lagos and Forcados is approaching completion. This line, which is being constructed overland from Lagos, will put the whole of both colonies in West Africa in telegraphic and cable communication with each other and with the outside world. It is intended to extend this landline to the Old Calabar seat of the Southern Nigerian Government.

Wireless Telegraphy.—The De Forest Wireless Telegraph Co. has recently made out a summary of the work done for Sir Thomas Lipton on board his steam yacht *Erin* during her stay in American waters. During the 73 days that the yacht was in New York waters, almost constant communication was maintained with the De Forest stations at Coney Island, State Street, N.Y., and Block Island. We are informed that the bulk of the matter transmitted was personal correspondence of Sir Thomas Lipton, and comprised 2,000 individual messages, making a total of over 40,000 words, and, in addition, 130 cables all in code. During most of the *Erin's* stay, the Associated Press and Publishers' Press had a reporter on board, and a total of 10,750 words were transmitted for the press, for which a collection of $25 per day was made. The average length of a message was 20 words, and frequently a message ran as high as 90 words. To transmit this bulk of business, it was necessary to send at an average speed of 32 words per minute. In length of time, speed, transmission and accuracy, under every imaginable weather condition and distance, this service is regarded as an excellent record. Sir Thomas has written to the company expressing in very high terms his satisfaction with the service rendered. The installation on the *Erin*, it is stated, is the first ever made on a private yacht, and its performance should augur well for its general adoption on this kind of craft.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—October 3rd. The Municipal Authorities of Liège are inviting tenders until October 3rd for the supply of six electric tramcars. Particulars may be obtained from, and tenders are to be sent to, Le Bureau Administratif des Travaux, à l'Annexe de l'Hotel de Ville, Liège.

Brighton.—October 5th. Steel rails, tramcars, points and crossings for the Corporation tramways extensions. See "Official Notices" September 11th.

G.W.R.—October 19th. Tenders are wanted for a year's stores, including electrical lamps, carbons, telegraph apparatus and instruments, copper and other wire. See "Official Notices" to-day.

Harrismith.—October 19th. Water-tube boilers, 25 and 80-kw. steam alternators, and other plant. See "Official Notices" September 25th.

Johannesburg.—October 5th. A large quantity of steel rails, fishplates, tie-bars, &c., for the Corporation tramways. See "Official Notices" September 11th.

Johannesburg.—November 16th. Gas producer plant; gas engines and dynamos. Alternative:—Water-tube boilers, steam engines or turbines, electric generators, and other plant. For the municipal tramways and electrical supply scheme. See "Official Notices" August 28th.

King's Norton.—October 10th. Overhead construction for three miles of line. See "Official Notices" September 25th.

Leeds.—October 17th. Surface condensing plant for the electric lighting department. See "Official Notices" to-day."

London.—October 6th. Four 5,000-H.P. vertical-horizontal steam engines, each suitable for driving a three-phase generator, for the Greenwich power station. See "Official Notices" July 24th.

London.—November 3rd. Engine, dynamo, wiring, &c., for an installation at the Abbey Mills Pumping Station at West Ham, for the L.C.C. See "Official Notices" to-day.

Manchester.—October 5th. 30-ton electric lift for the electricity department. See "Official Notices" September 25th.

Portugal.—October 21st. Tenders are being invited until October 21st by the Portuguese Ministry of the Colonies in Lisbon for the concession for the electric lighting of the town of Macao in the Portuguese Colonies.

Roumania.—October 10th. Tenders are being invited until October 10th by the Roumanian State Railway Authorities in Bucharest, for the installation of a complete electric lighting plant at the railway works in that city.

Salford.—October 19th. Sundry machinery for the Pendleton central car depôt. See "Official Notices" September 25th.

Salford.—October 19th. Electric lighting of the Pendleton Central Car Depôt. Specifications £3 3s. from the tramways manager.

Sheffield.—October 8th. 25 double-deck cars with trucks and equipments. See "Official Notices" September 18th.

Spain.—October 22nd. Tenders are being invited until the 22nd inst., by the municipal authorities of Aranjuez (province of Madrid), for the concession for the electric lighting of the town during a period of four years. Tenders are to be sent to El Secretario del Ayuntamiento de Aranjuez (Madrid province), whence particulars may be obtained.

Spain.—The municipal authorities of Onate are applying for a concession to put down a plant to utilise the water-power of the Olaran in the generation of electrical energy for lighting and power purposes.

Swansea.—October 31st. Permanent way, rails, special work, overhead equipment, cables, ducts, &c., for tramways. See "Official Notices" September 25th.

Swansea.—October 31st. Ducts, troughs, cables, wires, street boxes, &c. See "Official Notices" September 25th.

Sweden.—October 15th. Tenders are being invited by the municipal authorities of Gelfe until October 15th for the supply of six electrical cranes.

CLOSED.

Aston Manor.—The Council has accepted the tender of Messrs. Johnson & Phillips, for the following motors:—Enclosed, 50, 75, 100, 150, 200, 250, and 300-B H.P.; semi-enclosed, 150, 200, 250, and 300-B H.P.; open, 250.

Carlisle.—Messrs. Hemingway & Pritt, of Richmond-on-Thames have secured the contract for an installation of 500 lights at the County and Station Hotel, Carlisle. The same firm has also secured contracts for installing the electric light at Richmond Workhouse Infirmary, and Weir Bank, Teddington.

Darlington.—The A.B.P. Accumulator Co., Ltd., of Stockton-on-Tees, has received an order from the North-Eastern Railway Co., for a storage battery and reversible booster to be erected at their locomotive shops at Darlington, the contract price being £2,614.

Dartford.—The U.D.C. has accepted the tender of Callender's Cable & Construction Co., Ltd., for the supply of house service cable.

Derby.—Messrs. Edgar Allen & Co., Ltd., who recently took over the business of Askham Bros. & Wilson, Ltd, have secured (through the contractors, Messrs. J. G. White & Co., Ltd.,) the contract for the supply of cast-steel points with renewable centres of their Imperial manganese steel and iron-bound crossings of the latest American type with renewable centres, also in their manganese steel, for the Corporation Tramways.

Dewsbury.—The tender of Messrs. Siemens Bros. for the delivery and fixing of a 300-kw. dynamo with engine for the electricity works, has been accepted by the Gas and Electricity Committee.

Gillingham (Kent).—The U.D.C. has accepted the tender of Messrs. Cowans, Ltd., for a high-tension board at £75, and a low-tension board at £57, both for the Saxton Street sub-station.

Ipswich.—The T.C. has accepted the tender of Messrs. Hall & Hackblock, of Ipswich, for wiring the generating station and offices at £1,140.

London.—The Metropolitan Electric Supply Co. have placed an order for eight 500-kw. motor-generators with Messrs. Dick, Kerr & Co., Ltd.

London.—The Charing Cross & Strand Electricity Supply Co. has placed a large extension order for Peard patent junction box fuses with Messrs. Veritys, Ltd.

Manchester.—Messrs. Edgar Allen & Co., Ltd., have received a large contract from the Corporation for the supply of their cast-steel points and crossings fitted with hardened cast-steel renewable centres. This is the fourth large contract for points and crossings received from the Manchester Corporation by Askham Bros. & Wilson, Ltd.

Southwark.—The B.C. has accepted the tender of the General Electric Co. to supply 16,000 pairs of carbons at £4 1s. 3d. per 1,000 pairs.

Stepney.—Messrs. Royle, Ltd., the successful tenderers for the supply and erection of feed suction and other pipework, storage tank and softening plant for the B.C., have sublet portion of the work as follows:—Cast-iron tank and steam pipes, Messrs. Newton, Chambers & Co., Ltd., Sheffield; steel pipes, Messrs. Stewarts & Lloyds, Birmingham.

Sutton.—The tender of the Private Wire & Telephone Installation Co., Ltd., for installing a system of fire alarms in the Banstead Road Schools, Sutton, belonging to the Metropolitan Asylums Board, has been accepted.

Tynemouth.—The Corporation has placed the contract for a storage battery with the Electrical Power Storage Co.

Weymouth.—The Corporation order for lighting plant, which has been placed with the International Electrical Engineering Co., includes four high-speed engines by Messrs. Reavell and Co., of Ipswich. Messrs. Johnson & Phillips have placed with Messrs. Reavell an order for one high-speed compound engine of 150 B.H.P. for export.

FORTHCOMING EVENTS.

Friday, October 9th.—Holborn Restaurant (Crown Room); Electro-Harmonic Society. First Smoking Concert of the season.

Monday, October 12th.—At 7.30 p.m. Institute of Marine Engineers. Mr. R. Balfour on "Refrigerating Appliances as Fitted on Board Ships." Adjourned discussion, the London Institution, Finsbury.

Wednesday, October 14th.—At 6.45 p.m. Institute of Marine Engineers. Annual Dinner at Great Eastern Station Hotel, E.C.

NOTES.

German High-Speed Railways.—A report from Berlin says that, in order that immediate benefit may be obtained from the high-speed railway results already achieved, the Reichstag has voted a credit of £14,000 for further experiments. The money will be devoted to laying a new track on the Berlin—Zossen line. The electric trains on September 25th reached a speed of 189 km. (118 miles) an hour on the railway between Marienfeld and Zossen, near Berlin.

Electric Vehicle Trials in France.—The French daily, *Le Monde Sportif*, is organising a trial of electrical motor-vehicles to extend over four days. On November 19th there will be a run from Paris to Rouen (133½ km.); on the 20th, from Rouen to Abbeville (116½ km.); on the 21st, from Abbeville to Creil (132 km.); and on the 22nd, from Creil to Paris (90 km.). The trial will be divided into two classes, one for cars under 1,500 kg, and one for vehicles under 2,200 kg.

The Junior Institution of Engineers.—Mr. J. Fletcher Moulton, K.C., M.P., F.R.S., has been elected President of this Institution in succession to Colonel Edward Raban, C.B., R.E.

Shock Fatality.—On 24th ult., at Jarrow, an inquest was held into the death of W. T. Foster (38), a labourer, employed in connection with the electric light and drilling plant at Palmer's works. On 22nd ult. deceased was found in a reclining position in the pump house, with his right hand on the terminal of the starting switch. Current was immediately cut off, but Foster was found to be dead. Evidence showed that deceased might have taken a false step and put his hand out to save himself; he had been warned never to touch the terminals. The voltage was 440. The floor of the house was wet. The chief electrical engineer (Mr. J. H. Macro) said he would consider in what way the machinery could be further protected, but he thought the place was well guarded. A verdict of "Accidental death" was returned.

France.—The French Thomson-Houston Co. says there is no ground for the recently circulated report that a great French combine of the various big electric corporations is being negotiated.

The new Design of Electric Car.—Mr. Bristow has written us again on the subject of his patent car, enclosing sketches, but we must confess to remaining sceptical as to the advantages of the design. First of all the central entrance, whether arranged to avoid outgoing and incoming passengers meeting or not, has been tried on more than one line, and has been condemned on all hands as dangerous to life and limb, especially when the car is mounted on bogie trucks. Secondly, Mr. Bristow claims increased seating capacity, but, on his own showing, actually reduces the inside capacity, with longitudinal seats, from 30 to 24, although 22 is nearer the mark, if the comfort of passengers is to be studied. This shortage, plus the gain claimed, has to be made up by the supposed increased capacity of the top deck. How this can be done, if proper clearances are allowed, we do not see, as the area of top deck rendered unavailable for seats by the staircase opening is approximately the same, whether Mr. Bristow's patent or the ordinary reversed platform stairs are used. Perhaps, if some allowance were made for the trolley standard, comparison would be rendered easier. It is true that Mr. Bristow's arrangement of sliding partitions, if successfully operated in actual practice, would separate the streams of passengers alighting and entering; but the greatest difficulty of all, the intermingling and mutual hindering of the streams from the upper and lower decks, would remain. We feel that we may have treated rather harshly in our previous notes a man who seems to have tackled a serious question to the best of his ability. It only remains for us to regret that it should be possible for so much hard-earned money to be wasted annually on so-called inventions of this description; and to regret that, when the invention is described by the patentee, it should be rendered ridiculous by the wording of the description and by the absurdity of the claims.

Street Obstructions.—On September 23rd in the Chancery Division Mr. Justice Bucknill, sitting as Vacation Judge, had before him an *ex parte* motion on behalf of the Postmaster-General for a rule *nisi* for a prohibition against the justices of the peace of the City of London to restrain further proceedings upon two summonses issued against Sydney Byott and William Bailey, two servants of the Postmaster-General. Mr. W. S. Casserley, in support of the motion, said that the summonses in question were issued under the City Police Act, 1839 (2 and 3 Vict., c. xciv.), Sec. xxxv., Sub-Sec. 6, by which it was enacted that "every person who shall cause any cart, public carriage, sledge, truck or barrow, with or without horses, to stand longer than may be necessary for loading or unloading . . . . or who, by means of any . . . . truck . . . . shall wilfully interrupt any public crossing, or wilfully cause any obstruction in any thoroughfare" shall be liable to a penalty of not more than 40s. for every such offence. It appeared that on August 27th last the two defendants were employed to go to 72, Aldersgate Street, to search for faults in a cable in the footway box. Byott and a mate went about 11 o'clock and opened the box, and it was found that the cable was broken close to the pipe-mouth. A truck which was with the men was placed close to the kerb beside the box. The truck contained tools and material necessary for use in carrying out the repairs, and, according to the affidavits, was placed in the best position to avoid interference with the traffic. It was necessary to draw out the old cable and put in a new one. The work was not completed till 7 p.m., Bailey, in the meantime, having helped with it; and the present summonses for unlawfully causing the truck to stand longer than necessary for loading or unloading contrary to the statute were then issued. They at present stand adjourned till October 2nd. Mr. Casserley submitted that the justices had no jurisdiction to hear and determine the summonses. The City Police Act did not mention the Crown, and therefore was not binding upon its servants. From the report of the case in the *Times* we observe that Mr. Justice Bucknill granted a rule *nisi*, returnable at the first Divisional Court in the King's Bench Division, and a stay of proceedings in the meantime.

Personal.—Mr. William Cramp, A.M.I.E.E., late Lecturer on Electrical Design at the Central Technical College, has joined the Crypto Works Co., Ltd., 29, Clerkenwell Road, E.C., as electrical expert. His first duties will be to supervise the manufacture and development of repulsion motors of his own design for single-phase working, and up-to-date continuous-current enclosed motors.

Mr. V. Zingler, A.M.I.E.E., has severed his connection with the General Electric Co., Ltd., and has been appointed manager of the publicity department of the Edison & Swan United Electric Light Co.

Having accepted an appointment on the staff of Messrs. Frederick Braby & Co., Ltd., Mr. Ivon Braby, M.I.E.E., has resigned his position as joint managing director of the firm of Braby and Tomlinson, Ltd.

Mr. T. Vickers, C.E., who for over two years has had the management of the special track construction works of Messrs. Askham Bros. & Wilson, Sheffield, has resigned, and joined the tramway department of Hadfield's Steel Foundry Co., Sheffield.

Messrs. Thomas Parker, Ltd., of Wolverhampton, have appointed Mr. Ealey Hodgson their representative for the City of London and district. The offices are at Mansion House Chambers, 20, Bucklersbury, Queen Victoria Street, London, E.C.

Bond v. The British Electric Street Tramways Co., Ltd.—In the Vacation Court on Wednesday, before Mr. Justice Bucknill, this case was again mentioned. The motion was for an injunction to restrain the defendants from dealing with certain assets, and it being stated that there were hopes of a settlement being arrived at, the matter was directed to stand over for another week.

Electric Tramways in Russia: A New Government Condition to Exclude Foreign Competition.—It was recently stated in these columns that a number of Russian engineering firms and iron and steel producers had presented a petition to the Government praying that steps should be taken in connection with the proposed construction of electric tramways at St. Petersburg, Moscow and other towns, so that the orders should be preferentially placed with native firms, and that only in exceptional cases should contracts be given to foreign firms. This petition has now borne fruit, as, according to the St. Petersburg correspondent of the *Frankfurter Zeitung*, the new law which has just been published authorising the St. Petersburg Municipal Council to conclude a loan of 30,000,000 roubles for the conversion of the horse tramways to electric traction, contains a condition not previously embodied in such laws sanctioning the raising of municipal loans. The condition renders it obligatory on the part of the Municipal Council in the placing of orders for the works in question to give the preference to Russian firms, and only to consider foreign firms when the goods in question are either not produced in Russia, or the Russian offers are higher than the foreign tenders, inclusive of import duties. It is assumed that this stipulation will in future be imposed in the case of all municipal loans which are proposed for the execution of public works, as for instance, the construction of electric tramways, &c. The condition in question is, however, not so strict as in the case of State orders, as native works are given the preference in this respect, even if their prices are 15 per cent. higher than the tenders from contractors in other countries.

The Faraday Society.—As already stated in these columns arrangements for an interchange of publications between the members of the American Electro-Chemical Society and the Faraday Society have recently been made, so that in addition to their own Proceedings, members of the Faraday Society will in future receive the Transactions of the American Society, free of charge. The exchange will take effect with Vol. IV. of the American Transactions, containing the papers read before the recent meeting of the Society, held at Niagara Falls.

Accident.—Mr. William C. Hart, an employé of the Electrical Department of the Plymouth Corporation, met with a serious accident on Sunday morning. Whilst placing a new overhead wire in position in Westwell Street, he was knocked down from a ladder tower and received injuries to his limbs and concussion of the brain.

Lectures.—At the Morley College for Working Men and Women during the 1903-1904 session, which began on Monday at the Morley College, Waterloo Road, S.E., a course of 10 lectures, provided by the London County Council, and open to the public free of charge, is to be given by Dr. Fison on "Electricity," on Saturday evenings.

Special courses of instruction in electricity and magnetism, telegraphy and telephony, electrical engineering, &c., were commenced at the Polytechnic School of Electricity, Regent Street, W., on Monday last. The arrangements include practical workshop classes in motor construction and engineering.

Plant for Sale.—The sale of plant at the Newcastle-on-Tyne Electric Supply Co.'s station by Messrs. Wheatley Kirk, Price and Co. will take place on October 29th.

Appointments Vacant.—Junior assistant at Aldershot (25s.); engineer-in-charge for Belfast electricity works (£2 5s.). See our advertisements to-day.

Change of Address.—The British Miller Signal Syndicate, Ltd., has removed from 9—11, Fenchurch Avenue, E.C., to 122 and 123, Salisbury House, London Wall, E.C.

THE CENTRAL STATION ENGINEER.

Mr. C. E. C. Shawfield, the Wolverhampton borough electrical engineer, who has recently entered the bonds of matrimony, was on Friday in last week the recipient of two very handsome presents from the Corporation Electric Lighting Committee and from the staff at the Commercial Road Works. The present from the Committee took the form of a case of cutlery and a muffin dish. The staff gave a case of silver spoons and forks. The presentations were made at the works, Councillor Gough Allen, chairman of the Lighting Committee, officiating on behalf of the Committee, and Mr. Howie, chief electrical assistant, on behalf of the staff. A tribute to Mr. Shawfield's worth was added by the Mayor of the borough (Alderman G. R. Thorne), and by Alderman Mander. Mr. Shawfield, in the course of his reply, referred to the eight years' association he had had with his staff, none of whom had left him to go elsewhere. Of that fact he was very proud, and he considered he had the best staff in England. The Lighting Committee Mr. Shawfield described as the model committee of the Council, judged by the brevity of their meetings, and the sound common-sense decisions to which they came.

Mr. Crinks has been appointed junior assistant engineer at the Bristol Corporation Electricity Works.

Hanley T.C. has appointed Mr. E. Rendell, of Wednesbury, to succeed Mr. S. Hutchins as junior assistant at the Electricity Works at a salary of £100 a year.

The Bristol Electrical Committee has recommended an increase in the salary of the deputy electrical engineer (Mr. H. Herbert Couzens) from £300 to £350.

Mr. Reginald G. Roberts, of Liverpool, has been appointed junior switchboard assistant at the Lancaster Corporation Electricity Works, and has taken up his duties this week. Mr. W. McBretney, B.Sc., is leaving Lancaster with the good wishes of the staffs at both the power station and Story Institute (where he has had charge of the development of the electrical laboratory), for the post of charge engineer at Ipswich.

Electric Driving in Locomotive Works.—Electricity is to be substituted for steam for driving the whole of the machinery at the N.E. Railway's locomotive works at Gateshead. The contract is a large one. Supply will be obtained from the Neptune Bank power station of the Tyneside Co.

Receiver Appointed.—We understand that on the application of debenture-holders a receiver has been appointed in Henry F. Joel & Co. and Thomas Potter & Sons United, Ltd., electrical and general engineers, of South Molton Street, Oxford Street, W., not in Henry F. Joel & Co., as has been stated in a contemporary.

NEW COMPANIES REGISTERED.

Cross Electric Engineering and Manufacturing Co., Ltd. (78,609).—This company was registered on September 23rd, with a capital £4,000 in £1 shares, to adopt an agreement with A. H. Sparkes and W. Carter, for the acquisition of the business carried on by them as manufacturing electricians, and to carry on the business of electricians, manufacturers of and dealers in all kinds of electrical machines, engines, instruments and appliances, &c. The first subscribers (each with one share) are:—A. H. Sparkes, 31 and 32, Kirby Street, Hatton Garden, E.C., electrical engineer; W. F. Carter, 31 and 32, Kirby Street, Hatton Garden, E.C., engineer; H. R. Smith, 106, Murray Street, New North Road, N., surveyor; T. E. Ferrando, 43, Napier Avenue, Southend, engineer; A. Abrahams, 118, Goldsmith Road, Park Road, Leyton, mechanic; W. H. Woods, 2, Prince's Parade, Muswell Hill, electrician; and J. Cutler, 3, St. Peter's Terrace, Clerkenwell Road, E.C., mechanic. No initial public issue. The number of directors is not to be less than three nor more than seven; the first managing directors are W. F. Carter and A. H. Sparkes, each of whom may hold office for 10 years, with £150 each per annum as remuneration; remuneration of ordinary directors as fixed by the company. Registered office, 106, Murray Street, New North Road, Hoxton.

Edison Manufacturing Co., Ltd. (78,647).—This company was registered on September 25th, with a capital of £100 in £1 shares, to carry on the business of electrical and mechanical engineers, iron and brass founders, makers of and dealers in mechanical and other novelties, phonographs, gramophones, records or other talking machines or appliances, projecting kinetoscopes, photographic films, X ray apparatus, electrical appliances and batteries, motor-cars, engines, &c. The first subscribers (each with one share) are:—G. C. Marks, 18, Southampton Buildings, W.C., civil engineer; J. H. White, 58, Grays Inn Road, W.C., manager; Emily M. Marks, Myrtle Cottage, Eltham, book-keeper; Amelia A. Marks, Myrtle Cottage, Eltham, private secretary; A. W. Matlys, 56, Chancery Lane, W.C., engineers; H. R. Kerslake, 56, Chancery Lane, W.C., engineer; and H. E. Doel, 56, Chancery Lane, W.C., engineer. No initial public issue. Registered without articles of association.

ELECTRICITY SUPPLY ACCOUNTS.

Islington Municipal Electricity Supply.

If the lay press is to be believed, the Islington Electrical Department has earned for itself an unenviable notoriety, in the municipal world, during recent years. Apparently its greatest short-coming last year was the inability to earn more than 4 per cent. gross profit, an amount which is insufficient to meet the financial charges of the concern; and present appearances indicate that radical changes will have to be undertaken before any marked improvement can be expected.

Mr. Gay, the borough electrical engineer, has, in the ordinary way, no easy task, and we fear that in the present crisis any reforms involving financial aid, which he may be desirous of effecting, will meet with unreasonable opposition.

General Statement for Year ending March 31st, 1903.

Total capital expended	£388,081
Number of units sold—	
Private lighting	1,407,198
Public lighting	957,160
Total units sold	2,364,358
Equivalent number of 8-c.p. lamps connected	88,986
Number of public lamps	474 arcs, 16 inc.
Maximum load in kw.	2,100 kw.
Revenue Account. Gross revenue	£44,460
" expenditure...	£28,816
" profit	£15,644
Average price obtained, private lighting ...	5 7d.
" " public lighting ...	3 5d.

Revenue Account.

	Gross.	Per unit
By sale of energy	£43,549	4·42d.
Meter rents, &c.	637	·06d.
Sundries	274	·03d.
	£44,460	4·51d.

A diminished ratio of increase of supply, compared with previous years, appears to be responsible for the revenue failing to realise expectations.

Working Expenses.

	Gross.	Per unit.
Coal and other fuel	£12,863	1·30d.
Oil, waste, water and engine room stores ...	1,997	·20d.
Wages incurred in generation and distribution	4,089	·41d.
Repairs and maintenance of plant, buildings, &c.	3,290	·33d.
Works and distribution costs	£22 230	2·24d.
Attendance, repairs, &c., public lamps	2,255	·23d.
Rent, rates and taxes	1,386	·14d.
Management expenses, salaries of engineer, and clerical staff	2,065	·21d.
General establishment charges, printing, stationery, insurance and law	880	·09d.
Works costs	£28,816	2 91d.

During the past year, the works costs have crept up a farthing per unit, fuel, repairs and rates and taxes, being responsible for this, and, including the item of public lamps, they now reach nearly 3d. per unit.

Such a schedule of costs requires serious consideration. The fuel item is high even for London; the stores item, although a slight reduction on the previous year, is excessively high, and both wages and repairs are above the average.

Profit Statement.

To interest and sinking fund on loans	£17,309
Sundry payments	75
Balance, being loss on year's working	−1,740
Gross profit	£15,644

The balance carried down to revenue account, together with a small balance from property, amounts to £15,644, and, as financial charges demand some £17,309, and a further sum of £75 is allocated, the loss on the year's working amounts to £1,740.

A small memorandum contained in the accounts shows that since the commencement, net losses amounting to £8,344 have been incurred, partly balanced by net profits of £6,079, leaving a sum of £2,265 to the bad on seven years' work. The remainder of this memorandum is calculated to be entirely misleading to the lay reader, as a final result, under the heading of net profit, of £19,149 is arrived at; this is owing to the inclusion of sinking fund payments amounting to £21,414.

ELECTRIC TRAMWAY ACCOUNTS.

Newcastle-on-Tyne and Portsmouth Municipal Tramways.

The returns of the municipal tramway systems of Newcastle-on-Tyne and Portsmouth are of an exceedingly interesting character. Both concerns were purchased from pioneer companies and converted to electrical working, new routes being opened up at the same time.

A considerable amount of attention was drawn to the Newcastle-on-Tyne tramways during the recent municipal electrical visit, and the excellent character of the plant and services was noticeable. A number of severe gradients exist on the various routes. The traffic statistics during the last five years are as follows:—

Year.	Miles of route.	Car-miles.	Passengers carried.	Total receipts.	Receipts per route mile.
1898 ...	8	740,022	6,486,362	£42,377	£5,300
1899 ...	8	749,461	7,257,175	£46,195	£5,774
1900 ...	8	761,121	7,467,694	£48,476	£6,060
1901 ...	Track under reconstruction for electric traction.				
1902 ...	18½	2,893,798	29,558,219	£132,937	£7,186

The last year shows the results achieved since the Corporation took over the system, and they reflect great credit on Mr. A. E. Le Rossignol, the general manager and engineer, and on his staff which numbers all told 1,336 persons.

In the Portsmouth undertaking the gradual supersession of horse-cars is taking place, and with their total disappearance the working of these lines should compare with the best—in point of efficiency. The maximum gradient on these routes is 1 in 17. As at Newcastle, the department owns a separate generating station and obtains its power at a cheap rate. The following comparisons of analysis of working expenses at several tramway power stations is of interest; although, owing to the practice of supplying for other purposes besides tramway work, the works costs are not strictly representative.

	Newcastle.		Portsmouth.		Glasgow.		Hull.	
	Per unit.	Per car-mile.	Per unit.	Per car-mile.	Per unit.	Per car-mile.	Per unit.	Per car-mile.
Fuel	·14d.	·25d.	·17d.	·47d.	·16d.	·15d.	·60d.	·56d.
Wages, &c. ...	·17d.	·31d.	·42d.	·19d.	·17d.	·17d.	·15d.	·14d.
Oil, waste, &c.	·03d.	·06d.	·08d.	·10d.	·03d.	·03d.	·08d.	·07d.
Total works costs	·34d.	·62d.	·67d.	·76d.	·36d.	·35d.	·83d.	·77d.

In the case of Newcastle some 200 public arc lamps are supplied. At Portsmouth energy is supplied to the Cosham and Horndean Light Railway, and both the Glasgow and Hull tramways departments assist their lighting departments at times of heavy load.

General Statement.

	Newcastle-on-Tyne.	Portsmouth.
12 months ending—	March 25, 1903	March 31, 1903
Length of route	19 miles	14½ miles
Total length of track	38½ „	28½ „
Number of cars in use	140	80
Car-miles run	3,379,119	1,628,749
Passengers carried per annum ...	33,474,122	16,355,692
Capital expenditure to date ...	£903,594	£620,238
Traffic receipts	£150,334	£74,474
Total receipts	£153,822	£77,804
Working expenses	£89 313	£36,961
Gross profit	£64,509	£40,843
Income per car-mile	10·93d.	†12 37d.
Working expenses per car-mile ...	6·35d.	†5 44d.
Interest and sinking fund per car-mile	3·72d.	†4·68d.
Sundry charges	23d.	†1·14d.
Total expenses per car-mile ...	10 30d.	†11·26d.
Profit or loss per car-mile ...	+·63d.	+1·11d.
Cost of energy „	·62d.*	·76d.
Average fare per passenger ...	1·08d.	—
Revenue per mile of route ...	£8,096	£5,790
Expenditure per mile of route ...	£4,700	£2,543
Total number of units used ...	6,063 570	1,778 266
Units used per car-mile	1·79*	1·03

* Includes energy required for lighting 200 public arc lamps.
† Include results of horse traction totalling 42,424 car-miles.

From the above table it will be seen that both systems are worked with a considerable margin of profit—the northern town has the more extensive service, which accounts for the smaller margin between income and working expenses. The working expenses in the case of Portsmouth are exceedingly low, and excluding the horse traffic returns amount to only 5·12d. per car-mile.

Great credit is due not only to Mr. Spaven, the general manager, but also to Mr. E. Rotter, the engineer to the Portsmouth system, under whose guidance the system was planned and the working organised and carried on until March, 1902.

In the case of Newcastle, the working expenses less the proportion due to arc lighting amount to 6·17d. per car-mile, also a very creditable figure when the frequent services are taken into account.

Analysis of Working Expenses per Car-Mile.

	Newcastle-on-Tyne.		Portsmouth.	
Year	8½ mths., 1902.	1903.	1902.	1903.
Traffic expenses, including wages of drivers, conductors, &c., car-shed expenses	4·52d.	3 78d.	2·99d.	3 05d.
Electrical energy	1·26d.	·62d.	1·08d.	·76d.
Tickets, &c.	·41d.	·25d.	·08d.	·09d.
Management and general expenses, including salaries, printing, &c., sundries ...	·46d.	·23d.	·21d.	·36d.
Rent, rates, taxes and insurance	·40d.	·41d.	·28d.	·42d.
Repairs and Maintenance—				
Track	·01d.	·32d.	·18d.	·02d.
Overhead equipment	—	—	—	·02d.
Rolling stock	·86d.	·57d.	·42d.	·36d.
Buildings and plant	—	·11d.	·02d.	·04d.
Public lamps	—	·02d.	—	—
Public lighting	—	·03d.	—	—
Total working expenses... ... (electrical section)	7 92d.	6·34d.	5·26d.	5 12d.
Working expenses (horse section)	—	—	9 04d.	17·60d.
Total working expenses... ...	7 92d.	6 34d.	7·28d.	5·44d.
Percentage of working expenses to receipts for 1903.	57 84 %		Elec., 42·25 % Elec. & horse 44 00 %	

In disposing of its handsome gross profits the Newcastle tramways department has allocated £52,408 to interest and sinking fund for the period since the tramways commenced running, a further £3,250 has been set aside for depreciation purposes, and the

balance carried down (for 13½ months' working) amounting to £17,045, has been advanced to the Finance Committee for the purpose of liquidating financial charges which accrued during the period of construction, with the exception of £766 carried forward. The comparatively small amount set aside for depreciation purposes is probably explainable by the other heavy charges which the department has met, but the necessity of providing for depreciation having been recognised, this will, no doubt, be remedied next year.

The Portsmouth department has placed a sum of £32,847 to interest and sinking fund; £1,643 disallowed by the Local Government Board, and another small amount, complete the list of disbursements, nothing being allowed for depreciation, and a balance from the last two years' working of £13,165 being carried forward. In this case the balance carried forward is exceedingly satisfactory, and would be more so if it were certain that it would not eventually be used for the relief of the rates.

Profit Statement.

	Newcastle.	Portsmouth.
Interest and sinking fund	£52,408	£32,848
To discounts, &c, disallowed by Local Government Board	—	1,643
To depreciation on uniforms, equipment, rolling stock, &c.	3,250	—
Total balance carried forward	17,045	13,165
Less last year's balance brought forward	— 8,149	— 6,713
Gross profit on year's work ...	£64,509	£40,843

CITY NOTES.

Dick, Kerr & Co., Ltd.

Mr. Claud T. Cayley presided at the annual meeting of this company, held at Cannon Street Hotel on Tuesday. In moving the adoption of the report for the year ended June 30th (of which an abstract appeared in our last issue), the chairman said that the liabilities of the company had been increased, owing to the absorption of the English Electric Manufacturing Co.'s works at Preston. Dating from March 31st last, they had been entirely under the management of this company. Since the last balance-sheet they had increased the reserve fund by £70,000—thus £16,735 as required by clause 31 of the trust deed securing the debentures, and a further sum of £23,264, making a total of £40,000; in addition to that, they had carried out of the profits of the English Electric Manufacturing Co., Ltd., a further sum of £30,000 direct to reserve. This, therefore, with the special reserve fund of £32,611 added to the previous amounts, made the total reserves £161,559, and, adding to this the carry forward from this year of £35,544 18s, they had a total of £197,104. They were pursuing a conservative policy in building up these large reserves. On the assets side the capital expenditure had been increased by the purchase of the works at Preston. The plant and machinery had been amply depreciated. Contracts due for work, stock of materials, &c., were in excess of last year, but up to June 30th they held certificates from the various corporations and companies amounting to considerably over £300,000. These certificates were as good as cash, and since then most of this money had been received. The works at Preston were now fully occupied in manufacturing machinery. They were capable of turning out the largest direct-current and three-phase generators yet designed, together with all sizes of traction and stationary motors, controllers, &c. It has been found necessary to make a large addition to the present buildings to cope with contracts, and the new buildings would be ready for occupation in about a month, when they would be of great advantage in dealing with orders on hand, and ought to result in a considerable saving to the company. In a trading company of this description, the directors did not consider it wise to go too much into detail, but in these days of keen competition, and seeing that this was their first general public meeting, it might be stated that since the brief period they had entered the electric traction field they had completed, and had in course of construction, permanent way, overhead lines and cables, rolling stock and electrical equipment, generating plant, including steam engines, boilers and generators, and general engineering, amounting in round figures to about 7½ millions sterling. Except for a short time previous to their entering into the electric traction field, all the electrical machinery, steam engines, generating plant and rolling stock required for their various contracts had been manufactured in this country and by British labour. In addition to the home contracts, they were at the present time engaged in the construction and equipment of tramways in Mandalay, Singapore, Hong Kong and Tokio, and had also supplied machinery for and equipped important undertakings in South Africa, and had in hand important contracts in South America, Australia and Canada. The policy of the board had been not to depend merely upon the home market, but to develop steadily the field of operations of the company throughout the Empire and abroad. The works at Kilmarnock were fully employed on their own special manufactures, and were likely to be for some time to come. They were principally engaged in the manufacture of narrow-gauge rolling stock, points and crossings for portable railways, turntables, and special work for tramways. The prospects for the current year showed every indication of good results. After making a brief reference to the death of Prof. S. H. Short, to the additions made to the board by the election of three of the English Electric Co.'s directors, and to the change of offices from Cannon Street to Abchurch Yard, the chairman moved the adoption of the report, and the payment of dividends and bonus recommended therein.

Mr. R. H. Prestwich reconded, and it was carried unanimously.

The re-election of directors and auditors, and a vote of thanks to the board, with special reference, also, to the staff, brought the meeting to a close.

Mersey Railway Co.

The report for the half-year ended June 30th last, submitted to the meeting on the 29th ult., states that receipts from all sources have been £32,278, as compared with £31,781 for the corresponding period of 1902. Working expenses, exclusive of the exceptional charges for pumping, ventilation and lifts, have been £27,375, or 84·41 per cent., as against £23,066, equal to 72·58 per cent., for the corresponding six months. These exceptional charges for pumping, ventilation and hydraulic lifts for the past six months amounted to £4,686, equal to 14·52 per cent., as compared with £6,389, or at the rate of 20·10 per cent., in 1902. The number of passengers conveyed had been 3,201,644, as against 3,104,294 for the corresponding period of 1902, exclusive of season ticket holders. The net revenue account shows a debit balance of £3,728. This, added to the previous debit of £4,924, makes a total of £8,652. The working of the railway by steam locomotives ceased on May 4th, 1903, and since that date it has been worked by electric traction. There has not yet been sufficient experience to enable a reliable estimate to be formed with regard to the probable receipts and expenditure of the new method of working, but the difficulties of ventilation have been overcome, and the suitability and capacity of electric traction for dealing with the traffic have been fully demonstrated.

Addressing the half-yearly meeting held in London on Tuesday, Mr. James Falconer said that the change to electric traction took place on May 4th. At the present time he could say that in regard to ventilation the tunnels were perfect. The stations were brilliantly lighted, and the train service was so frequent as to render time-tables unnecessary. The trains were very comfortable, and an improvement in speed had been effected. Safety was an important factor which the directors had fully considered, and he believed that their line was the safest in either Liverpool or Birkenhead, and great precautions had been taken in the design and construction of the plant. The only point at which a fire could originate was at the motors, and there the carriages were protected by a lining of asbestos, which was absolutely fireproof. Every precaution, in fact, had been taken against accidents. Too short a time had elapsed since the installation of electricity as the traction power to enable the board to tabulate reliable figures as to the financial results which were likely to accrue from the change. The accounts before the meeting only dealt with two months' working of the line under the new conditions. So far as the receipts were concerned, it was gratifying to find that the tide had turned. Up to the time of the alteration there had been for years a steady ebb in the amount received. Since the beginning of May, however, there had been a steady flow. He did not wish to mislead the shareholders by suggesting that while the growth had been gradual it had yet reached anything like the results which the board hoped it would, and must reach, before it could be of any value to the ordinary shareholder. The public were slow in giving up old methods of travelling until they were satisfied that the new ones were in every respect better. It was impossible yet to estimate the working expenses properly. The experience of every undertaking similar to theirs was, that the results arrived at in the early months were no indication at all of what might be expected afterwards.

Elmore's Trust.

The adjourned extraordinary general meeting was held at Winchester House on Monday, Mr. Alleyne Reynolds presiding. There was a very lengthy debate which, at times, became somewhat heated and was frequently of a personal nature, many of the shareholders thinking that liquidation was unnecessary at the moment, notwithstanding that the bank was holding a pistol at the head of the Trust. An amendment was moved by Mr. F. L. Rawson to adjourn the meeting until October 23rd in order to give time to further arrange with the bank. The amendment was carried. The chairman and other directors resigned, and, as the company was thus without a board, someone in the middle of the hall moved the election of Messrs. Orde, Marshall and Richardson, as directors of the company, and this was carried by the few who took any interest in this part of the proceedings.

Electric Railway and Tramway Carriage Works.

The annual meeting was held at Preston on 24th ult. The chairman referred to the statements which had been made to the effect that negotiations had been entered into regarding the consolidation of the British electrical industry, and that Dick, Kerr & Co. were at the head of the movement. He said that he had heard of no such negotiations, and denied everything which might lead people to think that the company was entering into any combination. Messrs. Richardson and Prestwich were re-elected directors. The chairman, in moving the adoption of the report and balance-sheet, said that the net profit, after charging for depreciation, was £16,594. A dividend of 8 per cent., absorbing £12,000, was proposed. £5,426 was carried forward. Since the opening of the works in March, 1899, very large orders have been executed.

Cape Town Consolidated Tramways and Land Co.

The report for the period ended December 31st last, states that the final section of the Camps Bay Tramway Co., Ltd. (namely, the Kloof line), extending from the terminus of the Cape Town Tram-Co.'s system in Burnside Road down to Camps Bay was opened on November 10th, 1902, thus completing the tramway system as originally designed. The total length of track now in operation is about 9½ miles, and while the directors look forward to a permanent increase in the traffic and receipts as the development in both the Oranjezicht Estates and the Cape Marine Suburbs proceeds, they have thought it advisable, during such period of development, to grant to the Cape Electric Tramways, Ltd., a lease of this company's tramways for three years from January 1st, 1903, on mutually advantageous terms. The profit and loss account shows a credit balance of £873.

City of Buenos Ayres Tramways Co.

The report for the half-year ended June 30th last shows gross receipts for the half-year £134,636, an increase of £2,238, and working expenses £95,712, an increase of £739, leaving £38,923, an increase of £1,499. From this must be deducted the debenture interest paid to June 30th last, £3,480, and adding balance of revenue account, 1902, £1,558, there is a disposable balance of £37,001. Working expenses amount to 71·08 per cent., as compared with 71·73 per cent. for 1902, being a decrease of 0·65 per cent. The municipal tax (included in the working expenses) for the half-year of 6 per cent. upon the traffic receipts amounts to £7,772. The number of miles run was 2,699,702, and passengers carried 16,161,000. The average fare was, in 1903, 3·974 cents gold, as against for 1902, 3·816 cents gold. There has been an increase in receipts from the goods traffic amounting to $4,834 paper. The company's petition for the necessary modification of its concession, with a view to the adoption of electric traction, is still before the Municipality of Buenos Ayres, and negotiations are proceeding in reference thereto, but the directors are not yet in a position to make any definite announcement. Out of the available balance of £37,001 the directors declare an interim dividend of 4s. per share, £3,000 is placed to the reserve fund, and £3,001 is carried forward.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to Oriental Telephone and Electric Co., Ltd., 50,000 6 per cent. cumulative preference shares of £1 each, fully paid, No. 1 to 50,000. The Committee has appointed Wednesday, October 7th, a special settling day in Bournemouth and Poole Electricity Supply Co., Ltd., provisional certificates (fully and partly paid) for a further issue of 4,500 ordinary shares of £10 each, Nos. 22,501 to 27,000.

Anglo-American Telegraph Co.—The board has resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending September 30th, 1903, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income-tax.

Western Union Telegraph Co.—The quarterly report for the quarter ending September 30th, 1903, shows a surplus on July 1st, 1903, of $13,019,724. A dividend of 1¼ per cent. on the capital stock of the company has been declared.

Salisbury Electric Light and Supply Co.—The directors have declared an interim dividend at the rate of 4 per cent. per annum, in respect of the half-year ended June 30th last, on ordinary shares.

Eastern Telegraph Co.—The directors announce the payment on October 15th of an interim dividend of 1¼ per cent. on the ordinary stock, tax free, in respect of profits for the quarter ended June 30th.

Direct West India Cable Co.—A meeting of this company was held at the offices, 33, Old Broad Street, E.C., on September 24th. The proceedings were conducted in private.

Halifax and Bermudas Cable Co.—A meeting was held at the offices, 33, Old Broad Street, E.C., on 24th ult. The proceedings were not open to the press.

STOCKS AND SHARES.

Wednesday Evening.

Where lugubriousness, despite the little rally, still reigns in almost every department of the Stock Exchange, it would be too much to expect the electrical markets to remain better than steady. And that is the word which applies exactly to these markets. Sheltered as they are by the phalanx of investors who hold their stocks and shares as a permanent lock-up, electrical descriptions keep firm in an atmosphere charged with depression. The flatness of Consols has become such a usual event that we fear lest our readers wax weary of hearing the fact mentioned, but, risking that, it is needful to again refer to this slump in the premier security by way of partial explanation of the general distress that has seized upon the markets round the Stock Exchange. Money has to be raised to meet differences incurred in speculation, but, although the electrical sections are frequently affected by this influence, at the present time they have been but little disturbed by it.

The electrical railway stocks are all weak, as is natural enough in view of the fall in the steam traction varieties. Central London Ordinary gave way three points, and the Deferred one, City and South London was marked down 2 per cent. Even Waterloo and City has not escaped a fall of a point. All these movements are due simply to the financial situation, and have no bearing upon the merits of the undertakings. Districts have dipped to 32, and Metropolitan Consolidated to 81. East London has not recovered its last week's decline to 5, and Mersey stock stands about 6½. The 3 per cent. stock moved erratically between 7 and 12, and is now 9½. Great Northern and City Preferred keep at 8, and Great Northern, Piccadilly and Brompton are scarcely mentioned at their nominal price of 9¾.

Traction issues display little variation. Dublin Uniteds are at 13 and the Preference 15½, London United Preference being 11¾. Potteries Debenture has been done at 104¾, and a small inquiry for British Columbia Preferred Ordinary stock was not satisfied under 94. Westinghouse Preference shares are a dull market at 5 7/16 middle, and the selling proceeds from the North, where possibly the trouble caused by the Lancashire stoppages has made it necessary for money to be realised. There is some suggestion, too, of a new Debenture issue, but the directors are hardly likely to appeal for fresh funds at a time like the present.

In the Telegraph market business is confined to the transaction of a few investment orders day by day. A little selling is noticeable here and there, the Anglo-American Telegraph group, for instance, having eased off, despite the satisfaction expressed in regard to the dividends announced the other day. The Eastern section continues to withstand the general slump with remarkable tenacity, the dividends telling here to no small extent. Eastern Extensions are down ¼, and that is the only change to chronicle. West African Telegraph shares have not moved upon the most recent intelligence as to the progress of the telegraph on the Gold Coast. Commercial Cable Debenture is 2 down, by reason of the collapse in American Rails.

Three small declines in National Telephone stocks are ascribable to the general flabbiness of the markets. Both the Preferred and Deferred shed a point, and so did the 3½ per cent. Debenture stock; but there has not been so much pressure to sell, and with other markets so demoralised, it is somewhat surprising that the speculative Telephone issues should have held their ground as well as they have done.

In the Electricity Supply list, relapses of 5s. have occurred in London Electric Ordinary and Smithfield Ordinary, both being affected by the appearance of sellers. The shake-out round the House is leaving this market practically unscathed, and it is not difficult to sell shares at a trifle over the lowest prices quoted by the Stock Exchange Official List. Herein is fresh testimony, were such needed, to the inherent strength of this department, for in days like these, when first-class securities are an unwonted drug in the market, the test as to public confidence can be applied by looking to prices at which shares can be disposed of. Metropolitan first Debenture stock is a trifle harder; the bother in Marylebone about raising the necessary money in satisfaction of the company's award works rather in favour of shareholders, all things considered. The two Urban shares were quoted *ex* dividend on the Stock Exchange account day, September 30th. Kensington Debenture is down a trifle, and, in the miscellaneous list, the Debenture stock of the British Insulated Co., in receding a point, shows the only variation amongst the manufacturing investments quoted on the succeeding pages.

Eastern Extension, Australasia and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended June 30th last of 2s. 6d. per share.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Sept. 23rd.	Closing Quotations Sept. 30th.	Business done week ended Sept. 30th, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛— 3⅛	2⅛— 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	6½s.	6/6	46 — 49	45 — 48	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 93	91 — 93	92½	91⅝
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	7⅞— 8⅛	7⅞— 8	7⅞	7⅝
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	6 %	4⅜— 5⅛	4⅜— 5⅛	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	150 —160	145 —155 xd	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	93 — 96	90 — 93 xd	94	92
16,000	Cuba Telegraph	10	4½%	4 %	6½%	7 — 8	7 — 8	7	..
6,000	Do. 10 % Pref.	10	..	..	..	16½— 17½	16½— 17½	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2⅜— 3⅛	2⅜— 3⅛ xd	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8 xd	..	..
30,000	Do. do. 4½ % Debs.	50	..	..	..	98 —102 %	98 —102 %	..	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10¼— 10⅝	10½— 10⅝	10 11/16	10⅜
87,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	124 —129	124 —129	127	125½
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	90 — 93	90 — 93	91½	90
1,594,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	106 —109	106 —109	107⅝	106
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	12 — 12½	11⅞— 12⅛	12⅛	11 13/16
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	104 —107	104 —107	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	100 —103 %	100 —103 %	..	..
180,237	Globe Telegraph and Trust	10	5½%	5½%	..	8⅞— 9⅛	8⅞— 9⅛	8⅞	..
180,042	Do. do. 6 % Pref.	10	..	..	..	12⅞— 13⅛	12⅞— 13⅛	13 1/16	12⅞
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	22½— 23½	22½— 23½	..	..
62,500£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	37 — 40	37 — 40	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	98 —102	98 —102	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	100 —102	99 —101	100½	99½
1,966,667	Do. do. Def. Stock	100	..	..	4½%	76 — 78	75 — 77	76	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	5	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 96	93 — 95	..	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	101 —103	101 —103	103	102¾
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	1⅜— 1⅝	1⅜— 1⅝	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	5 %	..	6½— 7⅛	6½— 7⅛	..	..
3,803	Submarine Cables Trust	Cert.	..	..	..	116 —121	116 —121	..	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5⅛— 6	5⅛— 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅞— 5⅛	4⅞— 5⅛	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	104 —107	104 —107	..	..
15,609	West African Telegraph, Shares	10	..	..	2 %	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	..	12 — 12⅛	12 — 12⅛	13⅛	12⅛
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	100 —103	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	..	..
88,321	West India and Panama Telegraph	10	½%	..	..	7/16— 9/16	7/16— 9/16	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6¼	6 — 6¼	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3¼— 4½	3¼— 4½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	98 —101	98 —101	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	3 — 4	3 — 4	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	83 — 87	83 — 87	..	..
100,000	British Electric Traction	10	9 %	9 %	8 %	12½— 13	12⅝— 13	12⅝	12¾
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11½— 12	11½— 12	11⅝	..
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	122 —125	120 —123 xd	123½	123½
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	6⅞— 7	6⅞— 7	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	5⅜	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —106	103 —106	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	1/16— 1/8	1/16— 1/8	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	¾— 1⅛	¾— 1⅛	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1 — 1⅛	1 — 1⅛	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
35,000	Callender's Cable Construction shares	5	15 %	20 %	15 %	11½— 12½	11½— 12½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	106 —110	106 —110	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	97 —100	94 — 97	96¾	94
494,998	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	99 —102	99 —102	..	..
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	100 —103	99 —102	..	..
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	58 — 60	56 — 58	58⅝	57
85,000	Crompton & Co., Nos. 1 to 85,000	3	8 %	7½%	5 %	2 — 2½	2 — 2½	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	100 —104	100 —104	102	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	1½ — 2¼	1½ — 2¼	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82	76 — 81 xd	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅝— 1⅞	1⅝— 1⅞	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2⅜— 3	2⅜— 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	98 —101	98 —101	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	9½— 10	9½— 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	97 —100	96 — 99 xd	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	14 — 15	14 — 15	..	..
35,000£	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5⅛	5 — 5⅛	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	18½— 19½	18½— 19½	18⅝	..
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	4⅜— 5	4⅜— 5⅛	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10⅜— 10⅝	10⅜— 11	..	..
37,350	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	34 — 37	34 — 37	35	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	100 —103	100 —103	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	94— 97	93 — 96	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

National Electric Free Wiring £—½.

Oldham, Ashton and Hyde Electric (£10 pd.), Ord., 14½—14¾.
Do. do. Pref. £10 pd.), 10—10½.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME,	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Sept. 23rd.	Closing Quotations Sept. 30th.	Business done week ended Sept. 30th, 1903. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	‡	..	..	..	⅜—⅞	⅜—¾	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	1	..	..	..	118 —121	116 —119 xd	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	100	..	..	..	10⅜— 11⅛	10⅜— 11⅛	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	6 %	8 %	8 %	10⅜— 10⅝	10⅜— 10⅝	..	..
50,000	Charing Cross and Strand Electricity Supply	5	..	..	..	10¼— 10⅜	10⅜— 10⅝	..	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	9 %	10 %	10 %	9 — 9⅛	9 — 9⅛	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	5⅞— 6	5⅞— 6	..	..
250,000	Do. do. 4 % Deb. Stock Red.	5	..	..	..	4⅝— 5	4⅝— 5	..	..
44,436	*Chelsea Electricity Supply, Ord.	100	..	..	..	104 —106	104 —106	105	104
150,000	Do. do. % Deb. Stock Red.	5	5¼%	4 %	4½%	5⅜— 6½	5⅜— 6½xd	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	Stock	..	..	..	108 —111	108 —111	109½	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	0 %	5 %	5 %	10¾— 11	10¾— 11	10⅝	..
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	10	6 %	..	..	13 — 14	13 — 14	13⅛	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	..	..	..	..	122 —127	122 —127	125/4	123½
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	100	..	..	..	102 —105	102 —105	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	4 %	4 %	4 %	7⅞— 8⅛	7⅞— 8⅛	8⅛	..
400,000	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red ..	10	..	..	..	11⅛— 12⅛	11⅛— 12⅛	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	..	..	..	..	109 —112	109 —112	109¼	108¼
30,000	Do. do. 6 % Cum. Pref.	5	7 %	7 %	7 %	6⅞— 7	6⅞— 7	6⅞	6 7/16
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	..	..	..	..	6⅞— 6⅞	6⅞— 6⅞	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	100	..	..	..	107 —110	106 —109	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	5	12 %	10 %	10 %	10½— 11⅛	10½— 11⅛	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	Stock	..	..	..	103 —106	101 —104 xd	..	..
49,840	Do. do. do. 6 % Pref.	8	..	..	..	2 — 2½	1⅞— 2⅛	..	..
250,000	Do. do. do. 4 % 1st Mort. Deb. Stock Red	5	..	..	..	5⅛— 5⅞	5⅛— 6	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	Stock	..	..	..	100 —102	100 —102	..	..
220,000	Do. do. 4½% 1st Mort. Deb. Stock	10	6 %	6¼%	7½%	17⅞— 18⅝	17⅞— 18⅝	18¼	18 1/16
250,000	Do. do. 5½% Mort. Deb. Stock Red	..	..	..	..	109 —113	110 —114	112½	..
10,852	Notting Hill Electric Lighting	Stock	..	..	..	97 —100	98 —101 xd	98	..
40,000	St. James' and Pall Mall Electric Light, Ord.	10	7 %	6 %	6 %	13 — 14	13 — 14	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	14½%	14½%	14½%	15 — 16	15½— 16½	15½	15
150,000	Do. do. do. 5½% Deb. Stock Red ..	5	..	..	..	8 — 9	8 — 9	8⅝	8 7/16
12,000	Smithfield Markets Electric Supply, Ord.	100	..	..	..	98 —101	98 —101	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	2½%	3⅛— 3⅜	3 — 3⅛	..	..
80,000	Urban Electric Supply, Ord.	5	..	..	1½%	3¾— 4⅛	3⅞— 4	..	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	5 — 5⅛	4⅛— 5⅛xd	..	..
110,000	Westminster Electric Supply, Ord.	5	..	..	..	5 — 5⅛	4⅛— 5 xd	5 3/8	..
28,141	Do. do. 5 % Cum. Pref.	5	10½%	10½%	12 %	13 — 14	13 — 14	13½	13⅜
		5	..	..	..	6 — 6⅛	6 — 6⅛	..	..

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, September 30th.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£38 10	..
a ,, ,, ...	per ton	£80	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£30	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	3d.	..
a ,, Caustic (75/80%).. ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	180/-	13s. inc.
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£8	..
a ,, Bichromate, casks.. ..	per lb.	2½d.	..

METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£180	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
p Babbitt's metal ingots	per ton	£43 to £135	..
c Brass (rolled metal 2" to 12") basis	per lb.	7d.	..
c ,, Tube (brazed)	per lb.	8¾d	..
c ,, ,, (solid drawn).. ..	per lb.	7¼d.	..
c ,, Wire, basis..	per lb.	7½d.	..
c Copper Tubes (brazed)	per lb.	9d.	..
c ,, ,, (solid drawn) ..	per lb.	9¼d.	..
g Copper Bars (best selected ..	per ton	£71	..

METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£71	..
g ,, Rod	per ton	£71	..
e ,, (Electrolytic) Bars ..	per ton	£67	..
e ,, ,, Sheets ..	per ton	£77	..
e ,, ,, Rod ..	per ton	£69	..
e ,, ,, H.C. Wire	per lb.	8¼d.	..
f Ebonite Rod	per lb.	3/3	..
f ,, Sheet	per lb.	3/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	3/-	..
h India-rubber, Para fine	per lb.	4/7½ to 4/8	dec.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	45/1½	..
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£11 5	2/6 to 5/- dec.
g ,, ,, Sheet	per ton	£13	..
m Manganin Wire No. 28	per lb.	3/-	..
g Mercury	per bot.	£8 7 6	..
d Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d ,, ,, ,, medium	per lb.	2/6 to 3/9	..
d ,, ,, ,, large ..	per lb.	4/- to 7/9	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/2	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	..
i Steel, Magnet, ace'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£118 to £119	£2 dec.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/6	1d. dec.
p White Anti-friction Metals—			
"White Ant" brand ..	per ton	£42 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5½d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4 5/8d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 5	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open.	*
Aberdeen	Sep. 26	1,248	+252	22,424	+ 2,964	10	—
Birmingham	,, 26	5,630	+227	197,745	+ 8,665	—	—
Bournemouth	,, 23	1,193	—	—	—	10½	—
Blackburn	—	—	—	—	—	12½	+1½
Blackpool	,, 24	1,500	—116	32,150	— 225	8½	—
Blackpool and Fleetwood	,, 26	904	—109	17,218	— 218	7½	—
Bolton	,, 27	1,845	+138	49,302	+ 6,439	25	—
Bradford	Aug. 23	4,267	+579	81,276	+13,000	41	+4
Brighton	Sep. 27	990	— 43	39,171	—	6½	—
Bristol	,, 25	5,151	+217	—	—	28	—
Burnley	,, 26	948	+237	—	—	7½	—
Barnsley District	,, 18	179	—	6,791	—	4½	—
Devonport	,, 18	534	+ 54	16,884	+ 475	5	—
Dudley—Stourbridge..	,, 18	874	+ 67	31,440	+ 8,078	18½	—
Gateshead	,, 18	889	+ 18	32,374	+ 4,610	10½	+ ½
Gravesend—Northfleet	,, 18	278	+ 73	9,028	+ 712	3½	—
Greenock—Pt. Glasgow	,, 18	692	+136	20,615	+ 1,586	7½	—
Hartlepool	,, 18	291	+ 9	10,199	+ 410	6½	+2
Kidderminster	,, 18	182	— 4	4,952	+ 182	4½	—
Merthyr	,, 18	205	+ 7	7,429	— 222	3	—
Middleton	,, 18	332	+ 64	12,324	+ 1,500	8½	—
Oldham—Ashton ..	,, 18	556	+ 31	21,503	+ 1,477	8	—
Peterborough	,, 18	191	—	5,555	—	—	—
Poole	,, 18	365	+ 33	11,661	+ 1,757	3½	—
Potteries	,, 18	1,677	— 3	58,175	+ 3,024	28½	—
Rotherham	,, 18	178	+ 15	6,172	+ 1,005	2½	—
Sheerness	,, 16	76	—	2,238	—	2½	—
Southport	,, 18	388	+ 99	12,080	+ 2,152	6½	—

British Elec. Trac. Co.

* Compared with the corresponding period of 1902.

Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open.	*
South Staffordshire ..	Sep. 18	961	+270	33,446	+ 4,660	21½	—½
Swansea	,, 18	542	+ 11	19,622	+ 1,652	5½	—
Taunton	,, 18	69	— 9	2,317	— 221	1½	+½
Tynemouth	,, 18	349	— 30	12,366	+ 932	3½	—
Weston-super-Mare..	,, 16	220	+ 21	5,028	— 457	2½	+½
Wolverhampton Dist.	,, 18	435	+119	14,746	+ 7,034	10½	+8
Wrexham	,, 18	135	—	3,513	—	—	—
Yorks. Woollen Dist...	,, 18	477	—	10,750	—	6	—
Cardiff	,, 26	2,004	+393	52,260	+15,455	14	—
Chatham & District Co.	,, 24	617	+ 22	20,511	+12,703	8·53	—
Dover	,, 26	254	+ 1	8,843	+ 59	3	—
Dublin	,, 25	5,084	+179	71,600	+ 6,452	46½	+ ½
East Ham	,, 26	729	+140	18,317	+ 5,527	5	+ ½
Glasgow	,, 26	14,634	+1552	230,687	+25,150	66	+ 9
Hull	,, 26	1,911	+192	47,709	+ 2,347	11	+ 1
Ilkeston	,, 23	183	—	—	—	4	—
Isle of Thanet	,, 26	862	—109	28,920	— 1,564	10½	—
Leeds	,, 26	5,740	+473	147,943	+ 8,607	41	—
Liverpool	,, 19	10,440	+180	381,517	+11,943	103	—
Manchester	,, 26	12,611	+6885	308,738	+191,657	72	—
Newcastle	,, 26	3,594	+581	—	—	17	—
Portsmouth	,, 26	1,951	+106	—	—	29	—
Salford	Aug. 24	2,856	+1185	79,409	+24,708	30	—
Southampton	Sep. 17	1,060	— 48	—	—	9	—
Sunderland	,, 27	1,226	+ 38	33,949	+ 1,664	20	+3
Central London Railway	,, 26	6,088	—511	78,453	— 3,488	6	—
City and S. London Ry.	,, 27	2,642	—886	32,090	— 4,213	6½	—
Dublin and Lucan Elwy.	,, 27	138	+ 26	1,899	+ 109	6½	—
Liverpool Overhead Ry.	,, 27	1,709	+237	22 905	+ 1,501	6	—

B.E.T. Co.

LONDON ELECTRIC LIGHTING STATISTICS.

In the new volume of London statistics which the London County Council have just issued, some interesting figures are given relative to the loans raised by the London County Council and the various Metropolitan Borough Councils for electric lighting purposes. It appears that in 1900-1 the Metropolitan Borough Councils raised the sum of £563,512, and that during the same period the London County Council raised the sum of £13,503. The total loans raised from April 1st, 1884, to March 31st, 1901, amounted to £1,698,210 in the case of the Metropolitan Borough Councils and their predecessors, and only £15,696 in the case of the London County Council. The outstanding loans on March 31st, 1901, were £1,645,803 in the case of the Metropolitan Borough Councils and £13,698 in the case of the London County Council.

In one of the tables the last column does not always represent the difference between the two preceding columns, because the adjustments in respect of interest on investments and exceptional expenses have been included.

Another condition which it is considered must affect the working of an undertaking is the running of a dust destructor in connection with it. This is the case with the undertakings of five local authorities, viz., Bermondsey, Fulham, Hackney, Shoreditch and Stepney. Different systems seem to be followed by these authorities in adjusting their accounts. In Fulham, for instance, the maintenance expenditure in respect of the destructor is included with, and is inseparable from, the other expenditure on generation of current, while an amount is credited to the accounts from the cartage department for destroying refuse. In Shoreditch the net cost of maintenance of the destructor is debited in the electricity accounts under the heading of fuel for the generation of current. A similar method is followed in Stepney, where a charge is made for steam from the destructor.

The Borough Councils and the Price Per Unit.

Some interesting figures are given showing that the average prices obtained for the supply of current are generally lower in the case of local authorities than in the case of companies. In the following table the various undertakings are set out in the order of lowest price obtained for private supply. Only such undertakings have been taken as have completed one full year's working:—

Local authority or company.	Year of working.	Average price per unit obtained.		Proportion of public lighting to total supply.	Excess of revenue over expenditure per unit sold.	Interest or interest and dividends paid per unit sold.	Surplus available for repayment of capital or depreciation per unit sold.
		Private supply.	Public lighting.				
		d.	d.	per cent.	d.	d.	d.
Stepney Borough Council	2nd	2·73	1·62	28	1·24	·70	·54
Shoreditch Borough Council	5th	3·09	2·46	25	·69	·47	·29
Poplar Borough Council	1st	3·44	3·44 (a)	43	1·49	1·10	·39
Hammersmith Borough Council ...	5th	3·75	1·98 (b)	22	1·44	·78	·66
County of London Co.—Northern districts (f)	4th	3·77	...	...	2·17 (c)	2·75 (c)	−·27 (c)
St. Pancras Borough Council	10th	3·94	2·45 (b)	24	1·30	·71	·59
Charing Cross and Strand Supply Corporation—West End undertaking ...	10th	4·00	1·99	4	1·85	1·58	·59
Southwark Borough Council	3rd	4·06	2·90	3	·63	·94	−·44
St. James and Pall Mall Co.	13th	4·21	2·45	2	2·19	1·69	·57
Hampstead Borough Council	7th	4·33	2·34	9	1·66	·80	·86
City of London Co.	10th	4·52	2·15 (d)	12	2·11	1·68	·46
London Supply Corporation	16th	4·55	...	...	1·71	1·41	·30
Kensington Co.	15th	4·65	...	...	2·00	1·55	·47
Westminster Supply Corporation ...	11th	4·66	1·93	(e)	2·43	1·81	·63
Crystal Palace District	9th	4·75	...	...	·46	1·94	−1·48
South London Supply Corporation ...	2nd	4·75	...	...	·48	[illegible]	·57
Metropolitan Co.	12th	4·92	1·95	(e)	1·99	1·83	·20
Blackheath and Greenwich Co. ...	2nd	4·96	...	...	1·44	2·64	1·08
Chelsea Co.	13th	5·07	...	...	2·81	2·02	·82
Woolwich District Co.	8th	5·11	...	...	2·26	1·93	·33
Islington Borough Council	6th	5·16	2·98 (b)	43	1·83	1·18	·65
Brompton and Kensington Co. ...	13th	5·54	...	...	3·42	2·08	1·34
Notting Hill Co....	11th	5·71	...	...	2·67	2·28	·43
County of London Co.—Southern districts (f)	5th	5·77	...	...	2·17 (c)	2·75 (c)	−·27 (c)
Averages for local authorities	...	3·87	...	26	1·31	·78	·54
" " companies	...	4·58	...	...	2·15	1·81	·44

(a) Poplar.—Including capital charges in respect of incandescent street lighting.
(b) Hammersmith, St. Pancras and Islington.—Including capital charges in respect of public lamps.
(c) County of London Co.—The figures for the Northern and Southern districts cannot be separated.
(d) City of London.—Including maintenance of public lamps.
(e) Proportion not available.
(f) County of London Co.—Average price obtained per unit over whole area of private supply, 4·47d.

Littlehampton.—At a meeting of the Council, Mr. Alwyn, formerly connected with the B.K.T. Co., attended and laid before the members his views on electric lighting. Mr. Alwyn took this step with a view to ascertaining how far the Council were prepared to support him in applying for a prov. order to supply electric light for the district.

RECENT STEAM TURBINE DEVELOPMENTS.*

By W. L. R. EMMET.

(*Concluded from page 523.*)

In our newer machines we are providing a heavy stationary collar below the lowest wheel, which can be used to support the wheels in case the step bearing is removed, and would serve as a brake to bring the machine to rest in case the step bearing should cut enough to allow the wheels to settle to a dangerous degree. Our experience has been that there is very little tendency to settlement of the shaft in case of such cutting, and this latter function of the collar will presumably seldom be called into requisition.

The oil for step bearings, and also for the upper bearings of machines, is delivered by a small electrically-driven pump, which operates continuously from the exciter circuit. In most of the large plants where we are installing turbines we have recommended in addition to these electrical pumps a weighted accumulator, with steam pump arranged to keep it full automatically. This accumulator, with its steam pump, affords an automatic reserve for the lubricating system. Its capacity is such that there would be ample time to shut down the units even if everything in the station should be stopped by the bursting of a boiler or steam pipe.

The 5,000-kw. machine in Chicago is the second of our vertical shaft turbines to be put into operation. The first machine of this type was one of 500-kw. capacity, installed by the Newport and Fall River Street Railway Co. This machine has been in daily operation since last June. During all this time its daily operation has been indispensable to the service of the plant, and there have only been two or three interruptions of a few minutes each which could be charged to its defects. It has, however, developed some minor troubles which have been the cause of some annoyance, and it has been very difficult to correct these owing to the almost continuous operation of the machine. With new types of machinery, which have to be put in service without any period of experimenting, some such difficulties and delays can hardly be avoided.

The only serious troubles at Newport have been with parts of governor and with valves which have given out owing to overstraining of springs or other mechanical causes which are easily corrected. These troubles have occurred as the result of continued service, and are being rectified as rapidly as it has been possible to analyse their causes and apply suitable remedies. Nothing has happened which suggests the possibility of a serious difficulty, and it can be safely predicted that a condition will very soon be

* A paper read at the Saratoga meeting of the American Street Railway Association.

reached in which the turbine can operate for an indefinite period with a very small expense for care and renewals.

Our machine at Newport has been tested, and has shown results decidedly better than the reported tests of steam turbines of other makes; but the conditions have been such that we have reasons to believe that decidedly better results can be produced with slight changes in nozzles and adjustments of pressure. Up to the present time we have not been able to experiment with this machine or properly analyse its performance owing to the almost constant requirements of service. We are, however, installing a second machine at Newport, and very soon expect to make a proper analysis of its performances and to bring both machines to a representative condition. All the experience which we can gain with these early experiments is, of course, available for the prevention of similar troubles and mistakes in other plants.

One important matter in connection with the introduction of our turbines has been the establishment of proper condensing facilities in order that the great benefits of high vacuum might be realised to the greatest possible extent. In turbines which we have tested the steam consumption has been reduced from 6 to 7 per cent. for every additional inch of vacuum above 25 in. Such a reduction is, of course, very important, and justifies large expenditure upon condensing apparatus. The fact that the turbine may be better than a condensing engine with equal vacuum must not be considered a reason for assuming that a condenser which is good enough for the engine is also good enough for the turbine. The selection of condensing facilities should be governed by the economic possibilities.

We have recently designed for some of our large new turbines, surface condensers which themselves constitute the base and supporting structure of the machine. These condensers are of very ample cooling surface and are so arranged that the maximum degree of vacuum is obtainable with a given amount of water. One feature of our turbine which is very advantageous in obtaining a high vacuum is that it can be easily so arranged that the air leakage is reduced to zero. The two points where the shaft passes through the casing are fitted with packings which are kept sealed by steam. Another advantage is that there is no oil in the steam and consequently that the exterior of condenser tubes is kept perfectly clean. Several turbines with condenser bases are now being built, and it is probable that there will be a large production of machines of this type.

I have mentioned above that no oil comes in contact with the steam in these turbines, and I need hardly call attention to the great importance of this fact. The condensed water can be delivered directly back to the boilers and all possibility of trouble in boilers from oil, dirt or scale is eliminated. Even in plants where feed water is good and cheap, this constitutes a great advantage since a considerable amount of heat is saved by using the condensed steam on account of its higher temperature. There is, however, no such thing as perfectly pure and clean natural water, and there are few boilers that in their average working condition are perfectly clean. Cleanliness in boilers improves circulation and evaporation, prolongs life and constitutes, therefore, a very distinct and definite advantage.

The designs of these first machines started at Chicago and Newport are now about two years old. They were entered into upon the basis of a very limited experience with the turbine, and nothing to guide us other than the theoretical possibilities which previous tests had demonstrated. The period which has elapsed since the conception of these designs has been occupied in a battle with the innumerable difficulties attendant upon the production on a very large scale of radically new devices. When we became convinced of the practicability and the advantages of our designs, we determined that the possibilities could only be developed quickly through production on a large scale and by a concentration of force upon the work. We consequently decided upon guarantees which we felt certain of fulfilment and upon prices which would be attractive to our customers, and have taken a large number of orders for machines of several sizes. We now have on our books contracts aggregating more than 200,000 KW. in steam turbine generating units. A large proportion of these machines are now either finished or well under way.

This immense production has been introduced at a time when our regular manufacturing facilities are strained to the utmost and when the difficulty of obtaining or sparing good men is very great. The trials and difficulties of such an undertaking are hard to describe. A vast amount of very expensive special machinery has had to be designed and built, and almost every step has required thought and experimenting. In such new work the average man cannot be made to advance with the same confidence that he does on established lines. He presupposes the possibility of difficulty or failure, and is constantly being brought to a halt and making mistakes that he would not make under different circumstances. Important processes are handled carelessly, and unimportant ones are unduly deliberated over. The strain is incessant and an abundance of faith is required by those who would direct such work.

As the work of developing these designs has advanced, experience has shown the possibility of better and simpler methods, and the steady continuance of experiments has extended our knowledge of the theoretical possibilities. Consequently, new designs have been proposed and developed, and we now have in production a large number of machines which we consider greatly superior to those which are now being put into service. This process of experimental development will continue, and the production and test of each new machine will extend our knowledge and make possible further advances.

Our machines at Newport and Chicago and other machines of about the same date are of what we call the "two-stage" type. The Newport machine has two compartments with three rows of moving buckets in each compartment, and the Chicago machine has two compartments with four rows of moving buckets in each compartment. Our later large condensing machines have four stages or compartments with two rows of moving buckets in each. All the details of their design have been worked out in such a manner that their construction is greatly simplified, and the steam economy will presumably be much increased.

Thus, such successes as we may accomplish in the future will be the result of the large experience which responsibility for our existing work has entailed. We have been through long trials and have combated many predictions of failure, but the facts seem to indicate that we have succeeded and to promise that we will in future accomplish greater successes.

Discussion.*

Mr. Emmet's paper lead to a lengthy discussion, in which part was taken by Vice-President Ely and Messrs. John I. Beggs, C. O. Mailloux, E. G. Connette, J. G. White and the author. Mr. Beggs said he is very hopeful that the prediction of the General Electric Co. that steam turbines will come into general use will be fulfilled. On the other hand, some of the best engineers in the country have expressed to him their doubts on the subject. At present there is nothing to do except to await the curves and tests which Mr. Emmet says are going to be made. He asked if there is not a new power looming up which may as far surpass the steam turbine as that machine surpasses the reciprocating engine, so far as economy goes—namely, the gas engine. If the predictions made for the gas engine, using either illuminating gas, producer gas or gas now produced as a bye-product, are to be relied upon, it appears that the present cost of the kilowatt-hour may be cut in two and possibly reduced two-thirds, no matter how high the economy of the present steam plant. He said that a large engine building concern in America has recently acquired the right to build there the Nüremburg gas engine, and that a 3,000-H.P. engine of this type will be installed at the St. Louis Exposition direct-connected to a 2,000-KW. generator. In the north-west, screenings now cost $3·50 a ton, which four years ago cost only $1·70, so that the importance of bringing down the cost of producing steam is of the greatest moment. Mr. Beggs said that at present a steam turbine unit, such as Mr. Emmet describes, including the generator, can be purchased for about the cost of the corresponding reciprocating engine, and he remarked that he does not think he is divulging a secret when he states that the Westinghouse unit employing the Parsons steam turbine can also be bought at the cost of the reciprocating engine of equal capacity. Owing to the slower speed of the reciprocating engine, the cost of the accompanying generator becomes one-half that of the engine itself, and that this amount is saved in the turbine is important. An element that comes up in the question of the use of gas engines is the greatly-increased cost of the engine itself, and it is a question of commercial calculation whether this will be compensated for in reduced cost of producing power.

Mr. Ely referred to the fact that in the new plant of the Lackawanna Steel Co., at Buffalo, N.Y., the gases from the stacks of the blast furnaces and the ovens are washed and used as fuel, enough fuel being thus supplied for an installation of 40,000 H.P. of gas engines. Most of the units are of 2,000 H.P. The engineer in charge is a Russian, and Mr. Ely added that in the matter of gas engines, their manufacture and use, Americans were far behind Europe. Mr. Beggs mentioned a case in the west where a large manufacturing establishment is building 80 ovens for the production of coke, and it is probable that the waste gases will be utilised in generating power. Mr. E. G. Connette suggested that since the gas engine question is a very interesting one it should be made a topic for discussion at the next meeting of the Association. Mr. Connette pointed out that 10 years ago at the Milwaukee meeting of the Association he predicted in a paper that the steam turbine would finally supplant the reciprocating engine.

Mr. Mailloux said that if gas is obtained at a cost which is below 20 cents per cb. ft., the gas engine will be at least as economical as the steam turbine, especially where coal is relatively high; but when a producer is required to make gas the situation is quite different. He referred to a case of a plant of 15,000 KW. for which he received estimates for a gas engine plant and also for a steam turbine plant. In the gas engine system the largest unit was about 2,000 H.P., and consequently it would be necessary to have something like 10 units; this would involve a larger building and a larger maintenance account owing to the greater number of units, and since the gas engine is not a simple device its cost of maintenance would not be small. He also found that to get the economy promised he would have to go into the chemical business; in other words, handle certain chemical bye-products; he was told that by the installation of a 3,000-KW. plant there would be something like $50,000 a year recovered in the form of chemical bye-products. The principal objection was that an initial outlay of over $1,000,000 was required, and in that particular case instead of coming out $100,000 ahead, as against the steam turbine, he would be nearly that much behind yearly.

Mr. Mailloux cited another case of a pumping plant in Mexico, where coal is $15 a ton delivered on a mountain 700 miles from the nearest coal mine. He found in that case that a gas engine operated with producer gas was better than a steam turbine, and would pay for itself in something like three or four years. He investigated a case in Arizona where power was to be used in lighting and traction, and he found that the cost was more nearly even, the company being one producing gas as well as electricity. After a careful investigation the steam turbine was adopted. A further investigation has shown that in the present state of manufacture the cost per kilowatt of the gas engine outfit is at least twice that of the steam turbine outfit. He has had a station operating at Newport, R.I., under his direction for a year, which has been run-

* New York *Electrical World*.

ning one steam turbine unit for a year, and for the last five or six months running two units of 400-KW. each. The results have been so satisfactory that recently an order has been placed for two turbine units of 3,000-KW. each. The cost of the latter is under $28 per KW., not including the piping or condenser. Mr. Mailloux considers one of the great points in the steam turbine is that it enables the station equipment to be greatly simplified, not only in detail, but also in those things which eventually tell in maintenance. There are fewer parts and no adjusting parts. A feature of the steam turbine of the greatest utility is its ability to use high superheat, there being no practical limit to the amount of superheat that may be used. A turbine using steam at a pressure of 150 lbs. and superheat up to 600° gives as good economy as the ordinary engine with perhaps 175 lbs. or 180 lbs. pressure, using fuel economisers. The cost of the station is less, the expense of running much less, and the cost of producing power much reduced. Mr. Mailloux said that the only drawback thus far brought to his attention in connection with the steam turbine is the fact that it is not economical without condensation, and, in fact, requires a very good vacuum. He has had some difficulty in obtaining a satisfactory vacuum, but has no doubt that, after some slight changes which he contemplates, the difficulty will be overcome. He feels sure that the condensing outfit for the turbine requires much more care and greater first cost, perhaps $3 or $4 per horse-power.

Mr. J. G White said that he agrees in the necessity of a high vacuum and high steam pressure with the steam turbine, and also on the advantage of reduced space and saving in initial investment and in oil and other supplies. However, what is needed to be known is, how the steam turbine can be depended upon as to reliability. Can we instal steam turbines to-day and be certain that they will start off without serious interruption, or at least, that, after a few weeks of operation, they can be depended upon to take up the regular load and carry it day after day? He said he understood that in Newport there are two turbines in operation, and that the original one, which gave considerable trouble, is now said to be down to a regular working basis, and that the second unit is in operation and running satisfactorily. He wished to ask how many stoppages there had been during the past 60 days, or during some definite period, in connection with this plant.

In reply, Mr. Emmet said that they had had experience in Schenectady with a 600 KW. turbine of the earlier type, and a vertical shaft turbine, which is the newest type at Newport. The Schenectady machine has been in service two years, and has been running almost continuously without any trouble of any kind. The machine located at Newport has carried its load continuously, and of the troubles experienced practically none interrupted the service. A record has also been kept of all stoppages, and service was only interrupted three times between June and September, the longest stoppage being less than 20 minutes. These were caused by a certain amount of trouble in the valves, which had to be corrected from time to time. If the Newport machine, as it stands now in its present condition, were improved and simply maintained by the renewal of the valve parts as they give out, it could be kept up and run at a small fraction of what it would cost to maintain a reciprocating engine of equal capacity. As to comparing gas engines and steam turbines, Mr. Emmet agreed with Mr. Mailloux that it is purely a question of cost of fuel as relates to the turbine in its present state of development. The calculated fuel economy of the gas engine in its best state of perfection is greater than that of any steam engine heretofore produced; but the very highest results obtained so far with the steam engine in the matter of fuel economy are not far below the results obtained from gas engines. The very best result from the gas engine show a thermal efficiency of 32 per cent., while the best result produced with highly superheated steam under favourable conditions in the steam turbine is something like 23 or 24 per cent. But gas engines operated on a commercial basis run nearly to 26 or 27 per cent., which figures are not much in advance of the best steam turbine performances. Furthermore, as pointed out by Mr. Mailloux, the gas engine costs probably twice as much as the steam turbine unit, and if the latter is credited with the simplifications surrounding it, the difference is much greater. The steam turbine needs no heavy foundation, and the ideal turbine plant will be far removed from the city, laid out on the lines of a coal yard, and an expensive building will not be required. On this basis the difference in cost will be greater than Mr. Mailloux has stated; and even if we capitalise the difference in fuel consumption between the two engines, the amount will not cover the difference in first cost.

Mr. Emmet said the steam turbine as it will be six months hence can be operated by a child indefinitely, virtually without maintenance. The wear and deterioration is nothing, and the whole plant can be reduced to an ideal condition of simplification. On the other hand, a producer gas engine plant involves an immense maintenance cost, and the maintenance of the engines will be twice that of steam engines, being twice as complicated, and less capable of perfect lubrication. If coal continues to increase in cost, and gas engines are improved at the same rate that the turbine has been improved, the time will come when fuel economy will be the only consideration, and gas engines will come into more extensive use. Mr. Emmet thinks, however, that the introduction of the steam turbine is certain to give the gas engine a long set-back.

Mr. Beggs said that only eleven months ago the quoted cost of the steam turbine unit was double what it really is to-day. This reduction has obviously been brought about by competition between the builders who have acquired the right to construct steam turbines in America. As to the gas engine, they in the States were in the same position that they were in three years ago with respect to the steam turbine—they scarcely knew anything about it. As to the size of units, even the builders of the steam turbine to-day question whether it is not more economical and more advisable to instal units of 2,000 KW. capacity than units of 5,000 KW.

Referring to the Newport plant, Mr. Mailloux said that the first 400-KW. unit was ready early last winter, and owing to a burn-out in one of the old units carrying the load, the turbine was pressed into service even though the packing had not been finished. It has not been stopped except during periods of light load, and then in order to complete the piping and adjustment of the unit. Little difficulty has been experienced in paralleling the two units; there was at first a slight hunting or some disturbance due to imperfect belting, which has been remedied. At first the attendants kept close watch of the unit, but they have now become so accustomed to the machine that it is left to take care of itself.

THE BRITISH ASSOCIATION, SOUTHPORT, 1903.

ON SINGLE-PHASE REPULSION MOTORS.

By WILLIAM CRAMP, A.M.I.E.E.

(Read before Section G, September 16th.)

(Concluded from page 462.)

PASSING on to the equations for current, we have, upon closing the circuit when one side of the coil is just coming into the field, a current made up of two terms—(A) the exponential term, (B) the ordinary sine wave. The term (A), which may usually be neglected in other alternating current apparatus, is often, in the case of the repulsion motor, of great importance. It is extremely difficult to show the value of this term in any phase diagram, but its general effect is to shift the rotor current slightly forward in phase, and to cause the torque of the rotor to sink to zero at a lower speed. The cases in which it is of greatest importance are those of the type of fig. 2, in which the number of turns per coil is large. I found its effects to be very

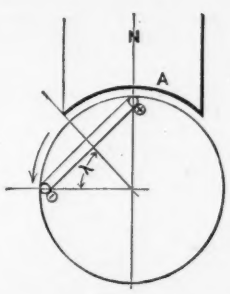


FIG. 4A.

strongly marked in the first two motors I made; but I do not anticipate that in future designs its effect will be so marked, for two reasons; first, because I now aim at few turns per rotor coil; and, secondly, because I use a greater number of commutator segments. Coming now to term (B), I think it is easier to consider the action of the motor from the standpoint of the Heyland diagram. Fig. 5 is a diagram showing the value and phase relationship of the various magnetic and electric quantities of a repulsion motor, and is drawn to scale in the way now common for induction motors and transformers. The lines represent, therefore, either instantaneous maximum values or root-mean-square values (according to the scale), and it is assumed that the useful flux crossing the air gap at a point, such as A (fig. 4A), is constant: a state of affairs not found in motors run at constant voltage. It is, however, necessary to consider this case first. In fig. 5, then, let O F represent to scale the number of useful magnetic lines which pass through the pole of the stator marked N in fig. 4A.

Now, we may resolve the field of O F in two directions in space—viz., along the line of the brushes and at right angles thereto. F D and D O will represent these components, the point D lying upon a semi-circle, as shown. The angle D F O is that corresponding to λ in fig. 4A. D F now represents the field which vibrates through the rotor coil, and D E, at right angles proportional to it, must represent *in time* the E.M.F. generated in the rotor coils. (It is better to keep time and space separate by arranging all quantities in *phase in time* in one plane. Thus D E would be drawn in a plane at right angles to that containing D F O, as is done in the author's model.) The E.M.F., D E, may be resolved into two components at right angles in time D G, G E. Of these two, G D is proportional to the C R drop in the rotor coil, and hence to scale (with constant rotor resistance) represents the magnitude and phase of the rotor current. G E represents that component of the rotor current tending to demagnetise the stator. The angle, ϕ_2, is the angle of lag of the secondary or rotor current. As ϕ_2 increases, the rotor C R drop D G decreases, and the rotor demagnetising component increases till E G = E D, when the rotor current is zero and the field F D is balanced. Now, since D E is proportional to D F, it may be drawn of the same length. Then the semi-circle, D G E, may be applied to the line, D F, so that E falls on F, and E G becomes F G^1, and shows the way in which D F becomes gradually

balanced. The angle G¹ D F then = G D E = ϕ_2. Now, the component of D G in phase with D F or D O is the projection of D G on D F = D C = D G sin ϕ_2. This component multiplied by D O is proportional to the torque of the motor—*i.e.*, the torque varies as the area of the triangle, D C O.

We have rotor current $\propto$ D G $\propto$ D E cos ϕ_2;

$$\text{D E} \propto \text{D F} = \text{O F} \cos \text{O F D} = \text{O F} \cos \lambda$$
$$\text{D O} = \text{F O} \sin \lambda;$$
$$\text{D C} = \text{D G} \sin \phi_2.$$

Hence torque at starting = D C × D O;

$$= \text{D E} \sin \phi_2 \cos \phi_2 \times \text{O F} \sin \lambda;$$
$$= \text{O F} \cdot \text{O F} \cdot \sin \phi_2 \cos \phi_2 \sin \lambda \cos \lambda;$$

which is a maximum when $\left.\begin{matrix} \sin \lambda = \cos \lambda \\ \sin \phi_2 = \cos \phi_2 \end{matrix}\right\} = \frac{1}{\sqrt{2}}$—*i.e.*, when

and $\phi_2 = 45$ degrees.

Now, O F $\propto$ primary voltage (nearly). Hence the starting torque is proportional to O F²—*i.e.*, to the square of the primary voltage.

These are the starting conditions.

Running Conditions.—Directly the starting torque is large enough, the rotor begins to revolve, the coil (fig. 4A) tending to set itself so that it encloses a minimum of the magnetic lines issuing from the stator. Thus motion takes place in the direction of the arrow in fig. 4A; and this must be due to the fact that the current sets up a field in the rotor coils, which is on the whole of opposing—*i.e.*, identical—polarity to that existing in the stator. Thus, if at a particular instant (in fig. 4A) the polarity of the stator is north, as marked, the polarity of the rotor field, due to the lagging rotor current, must at the same instant be north. At this particular instant the lagging rotor current must be in the direction shown by the cross (+) and dot in fig. 4A. By Lenz's law the E.M.F. set up by rotation must oppose this current. Therefore, directly the rotor begins to revolve, the rotor lagging current is reduced, or, in other words, the coefficient of self-induction of the rotor coil is virtually diminished. Suppose, now, the rotor is running, then the coil shown in fig. 4A, immediately it moves, would have its place taken by the one next it, and thus, although the rotor revolves, we may, as it were, speak of an "equivalent stationary coil," whose axis is settled by the diameter upon which the brushes are set. Considering now the coil shown in fig. 4A as representing this equivalent stationary coil, we see that its coefficient of self-induction may be altered to a certain extent by moving it round in the direction of rotation. In this way, however much the phase of the rotor current may be altered by the E.M.F. due to rotation, the original conditions may be reproduced by moving the brushes in the

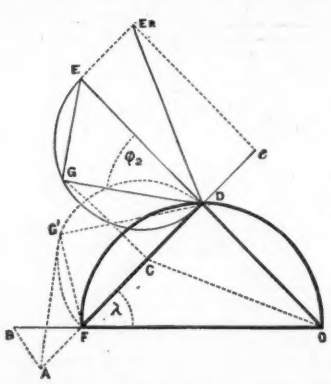


FIG. 5.

direction of rotation. Theoretically, this may be carried on till the axis of the coil is at right angles to the axis of the field, when the speed of the rotor is infinite. Naturally, in practice there is a limit, depending upon the particular form of stator and the torque necessary to overcome the friction of the rotor bearings, &c.

In order to show the E.M.F. due to rotation in fig. 5, we remember that it is really produced by the field D O, and, therefore, will be at right angles to D O in time. Thus it may be represented by D *e*, and its effect is obviously to reduce the secondary lagging current, thus reducing the primary lagging component and the total primary current. With increasing speed, then, the point G will tend to travel along its semi-circle. The value of the component

$$\text{D E} = \frac{e_1}{\sqrt{2}} \frac{t_2}{t_1}, \text{ whilst D } e = \frac{e_1}{\sqrt{2}} \frac{t_2}{t_1} \cdot \frac{n}{f}.$$

Thus at synchronism D *e* = D E, and if the motor started with maximum torque the point G will have arrived at E, when the motor attains to synchronous speed.

The above results are only approximately correct, for the following reasons. We have assumed (1) conditions of constant field which do not exist; (2) that the current-conductor distribution around the rotor is sinusoidal, which is not true; and (3) that the number of conductors acted upon by the field D O is the same as that under the influence of the field D F. Later I hope to have an opportunity of showing how each of these peculiarities affects the phase diagrams already given. For the present it is important to note that the machine will generate if revolved in the direction opposite to the arrow in fig. 4A.

Since the law of the diagram is so simple, a model may easily be constructed, ruled by the fact that O F is of constant length, and the point D moves along a semi-circle. From this model the values of primary and secondary current, torque, and power factor may readily be deduced, and the following peculiarities may be noted:

1. The *torque* depends on the relative phases of stator and rotor currents, and at starting it is a maximum when the power factor is about 60 per cent. At any speed the torque will always be a maximum with about this power factor, but in order to keep this maximum torque the brushes would have to be gradually moved in the direction of rotation as the speed rose. In the case of small motors, I should say that there is no reason at all why the brushes should not be moved forward, either automatically or by hand in this way, since, as already shown, sparking difficulties may be completely overcome.

2. *Power Factor.*—If maximum torque is required of the motor at starting, and the brushes are to be kept fixed, it follows that the power factor can never much exceed 70 per cent. This at first sight appears a serious drawback, but in actual practice there are many cases where it will be no disadvantage at all. Take, for instance, a small printing establishment, or a tramway system of no great length. The disadvantages of the lagging current are two-fold: (1) C^2R loss in the line—of small importance, as we have supposed the line short; (2) reduction of the voltage at the generating station by reaction upon the alternator fields, which is clearly counterbalanced by the fact that the power factor of such motors is a maximum at starting and gradually decreases as the stator current decreases while running. Thus the actual value of the lagging-current will not vary very seriously, and, so far as the engineer at the central station is concerned, should cause no trouble. In fact, the motor is in this respect in as good a position as a polyphase motor started with resistance in its rotor circuit, and in a far better position than any ordinary single-phase induction motor. In the case of large motors or long transmission lines, the power factor of the motor with maximum torque at high speeds may be very materially increased. One way of doing this is by means of slip-rings attached to the rotor windings, just as if it were a rotary converter. Resistances inserted between these slip-rings are gradually cut out as the speed rises, so that the motor finally acts as an induction motor, a device of mine incorporated in a repulsion motor arranged at the Central Technical College three years ago, and which I see from an article by Herr Schüler in the *Electrical Engineer* of September 4th has recently been the subject of an English patent.

3. *Efficiency.*—In any class of electromotor this is bound to depend largely on the amount of material put into it. Comparison is, therefore, admissible between motors of different types and of the same weight. In this connection my present experience does not enable me to give any definite figures, but I should say that the repulsion motor for a given power will be heavier than the corresponding polyphase motor, and far lighter than the single-phase motor with its starting apparatus. Considering the enormous waste of energy in starting the latter, the repulsion motor will be far more economical of energy for non-continuous running. Unfortunately, detailed results of actual output per KW. during continuous running are not yet forthcoming from any source.

4. *Starting Advantages.*—Under the best circumstances the repulsion motor may be started under full load with a current only slightly exceeding the full running current. This great advantage is obtained without any expensive and cumbersome starting arrangement, and it is this which must be put forward as the great advantage of this type of motor. Of course at starting the motor is really a special case of the split-phase type of motor, and the only reason why it is so much better than other motors depending on this principle, is that the phase splitting is performed by the motor itself and depends on no additional apparatus. Further, by careful design the phase difference produced at starting must be so very much greater here than in any starting apparatus for single-phase motors, except such as depend on the introduction of a very large condenser.

This paper must, of course, be considered as preliminary, in that no curves of results are given, but these I hope to have ready to publish shortly.

I cannot close without expressing my gratitude to Prof. Ayrton for the opportunities accorded me for carrying on this work at the Central Technical College, to Messrs. Fawssett and Ablett, students at the same institution, for much valuable help, and to the Crypto Works Co., who built the more recent experimental motors. Mr. Ablett was the first to point out the parasitic currents which existed in certain armatures of the type of fig. 2, and to suggest the remedy.

PROTECTIVE DEVICES FOR HIGH TENSION ELECTRICAL SYSTEMS.

By W. B. WOODHOUSE, A.M.I.Mech.E., A.M.Inst.E.E.

(*Read in Section G, September 14th.*)

THE extending use of high tension polyphase transmission is resulting in a gradual standardisation of the methods adopted to protect such systems against breakdown, but there is still some considerable diversity of opinion shown. The writer proposes to discuss several points in connection with the operation of a high tension polyphase transmission system.

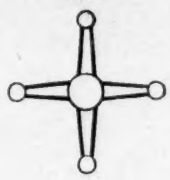
Nature of System.—Power is supplied to sub-stations through underground cables; in the sub-stations the converting machinery may consist of static transformers, motor-generators and rotary converters. The economical voltage of transmission is decided by the cost of cables; above 10,000 volts step-up transformers are needed at the generating end, but in such schemes as are working or projected in this country 10,000 volts is the higher limit.

The design of the system should be such that each part of the system is automatically disconnected in the event of a breakdown

of that part; the continuity of supply being of primary importance, all parts should be duplicated.

The duplication of feeders to each sub-station does not involve excessive expenditure when the generating station is at the centre of the area of supply, as in fig. 1, wherein two feeders are shown running from the generating to each sub-station; where this is not

FIG. 1.



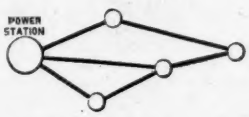


FIG. 2.

so, as when a number of sub-stations are closely grouped, such an arrangement becomes too costly, and inter-connecting cables must be run between the sub-stations to provide alternative ways of supply. Fig. 2 shows such an arrangement, which is the case more frequently met with.

In the first arrangement power always flows in the same direction along any cable; in the second, power may be required to be transmitted in either direction on any inter-connector.

Stresses on the System.—In switching on an unloaded cable a wave of pressure passes along the cable and is reflected; there may be a rise of pressure to twice the working value.

In switching on a transformer or an induction motor, or any apparatus with considerable inductance, the full pressure exists for the moment between adjacent coils, the greatest stress falling on the end coils. An inductive circuit has stored energy to the amount of $\frac{I^2 L}{2}$ joules, which must be dissipated when the circuit is broken. In a transmission system such as is considered this energy may be converted to the electrostatic form on opening circuit, with a resultant rise of pressure; neglecting damping effects, the pressure may rise to a value of $E = I\sqrt{\frac{L}{C}}$, or the rise of pressure is proportional to the current flowing at the moment of interruption. Pressure rise from resonance is not likely to occur in commercial systems in this country.

Protective Devices may be divided into two classes:—

1. Circuit breakers.
2. Devices which prevent or relieve excessive rises of pressure.

Circuit Breakers are required to operate automatically (*a*) on an overload, (*b*) on a reversal of the direction in which power is flowing. The overload device should be fitted to every circuit breaker; the use of the "return current" relay is limited to generator switches and those at the sub-station ends of feeders. Should one of a number of generators break down, power will flow from the sound machines to the faulty one, when the switch automatically opens. In a feeder system, as in fig. 1, should one of a pair of feeders break down, power will flow into the fault from both ends; the reverse current relay disconnects the sub-station end, and the overload relay the power station end. In such a system as is shown in fig. 2, it is obvious that the interconnecting cables can only be protected by overload relays.

The interval of time between the occurrence of an overload and the opening of the circuit should be inversely proportional to the magnitude of the overload, that is to say, on a moderate overload there should be a time-lag of some seconds.

A little consideration will show that all circuit breakers on a system should be capable of breaking the whole power which can flow into that part of the system.

Fuses.—The use of fuses as circuit breakers on H.T. systems has followed from L.T. practice. There are two main types in common use, the one in which strips of fusible metal 10 in. or 12 in. long are enclosed in a porcelain or glass tube, the arc being blown out by the heated air; the other type in which the fuse is a short wire or wires ½ in. to ¾ in. long, held in tension by springs over a pot of oil, the arc being quenched by the withdrawal of the contacts into the oil.

In the first type, which finds extensive use on the Continent, the fuse strips are made of tin, aluminium or silver; tin is most commonly used, but aluminium has been used because its high specific heat has advantages where a large time-lag is required.

The results of tests on these types of fuses are shown in fig. 3, in which the time taken for a fuse to blow after the application of a definite overload is marked as a point on a curve.

It will be seen that the second, the Ferranti type of fuse blows almost immediately the current reaches the fusing value, whatever be the magnitude of the overload, but the long fuse takes many seconds to blow on a moderate overload, and an appreciable time even on a heavy overload; or one has practically no time-lag, and the other has too much on heavy overloads.

In the design of fuse receptacles it must be remembered that in opening a circuit, power is absorbed by the resistance of the fuse. In an inductive circuit the maximum power put into the fuse (a non-inductive receiving circuit) occurs when the resistance of the fuse is equal to the impedance of the remainder of the system, and is $\frac{E^2}{2(r+z)}$. For the same power flowing under normal conditions, the power delivered to the fuse increases with a decrease of the power factor. Practical experience fully confirms this, and a fuse which takes some seconds to blow will absorb a considerable

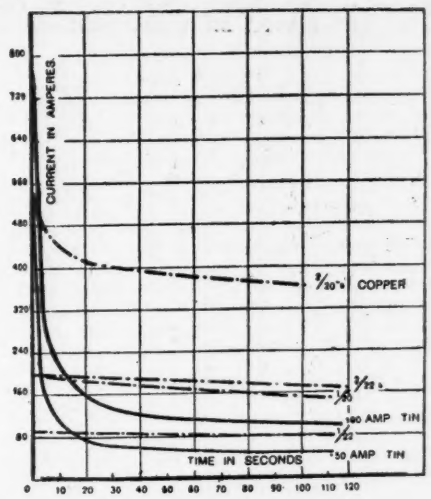


FIG. 3.

amount of energy. The exact rate of variation of the resistance of the fuse is a matter of conjecture, but fig. 4 shows curves plotted on the assumption of a uniform increase of resistance for two cases—1,000 KW. at 10,000 *v.*, cos $\phi = 1$: 1,000 KW. at 10,000 *v*, cos $\phi = 0{\cdot}5$.

The inheritance of fuses from L.T. working has not been an unmixed blessing; they become unreliable with age, and as a switch is necessary wherever a fuse is placed, it is becoming increasingly the practice to attach an automatic relay to the switch and dispense with the fuse altogether.

Potential transformers for operating instruments may be excepted from the above. The breakdown of such transformers is of rare occurrence, and they are usually protected by fuses of the tube type.

Switches.—It may be laid down as an axiom that any part of a H.T. system which allows an arc to play in air is bad, on account of the dangerous pressure rises which may be occasioned. Air-break or "flare" switches are hence to be avoided. Although a time-lag is advisable on circuit-breakers, yet the circuit should be opened

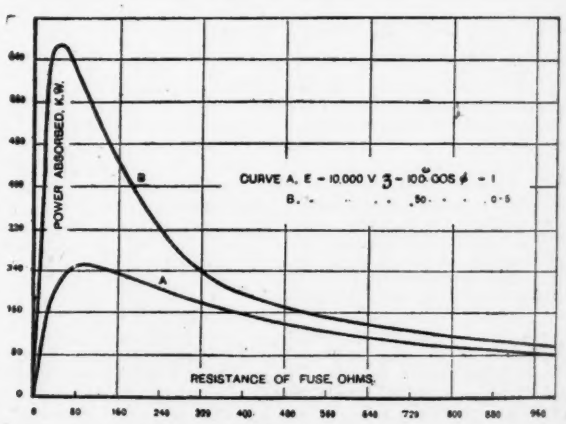


FIG. 4.

rapidly when once the operation starts; it is yet more important that the opening should take place when the current passes through its zero value. The results of many experiments seem to show that an oil-break switch does break circuit at the moment of zero current, and for this reason such switches are now generally adopted.

The switchgear is so designed that each switch is in a separate fireproof chamber of metal, brick, slate or concrete. For safety the switches, bus-bars, &c., are placed some distance from the operator, the switches being operated by links and levers, chains, pneumatically or electrically. In a large board the operation by means of electrical motors is the most convenient, as the "control board" may be made quite small. Control by means of D.C. motors finds most favour, as the D.C. is used also in the actuation of the relays, and may be supplied from a storage battery which is used for exciting. There should be no possibility of an arc on one

phase of a switch passing to another phase, or to any other metal work.

In switches for large currents contacts external to the oil are sometimes fitted so that there shall be no danger from heating of a contact in the oil; these external contacts do not make or break circuit, but are in parallel with the oil break contacts when the switch is closed.

Fig. 5 is a typical example of an oil-break switch for heavy work made by the British Thomson-Houston Co. The switch is operated by a direct current motor seen at the top. Circuit is made or broken on each pole in two cylindrical oil vessels containing the contacts, the top contacts consisting of two rods yoked together, and sliding through insulators. All the live metal parts are in

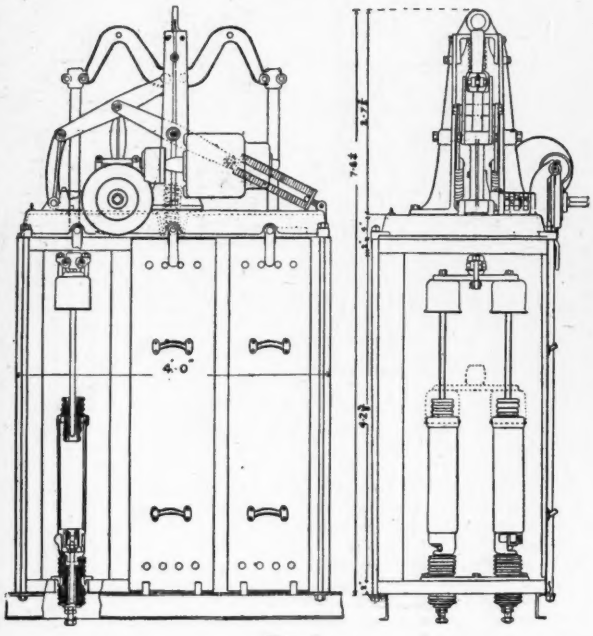


FIG. 5.

compartments made of brick and soapstone slabs, connection to the operating gear being made by wooden rods. The motor works a crank through a worm gear. When the crank is on a dead centre, a spring is compressed ready to operate the switch; the slightest movement of the motor causes the spring to come into play, and at the same moment a friction clutch releases the motor from the gear. The motor continues running until it has compressed the spring ready for the next operation, when an automatic switch opens the motor circuit and lights a lamp to indicate that the switch has acted. The motor is controlled by a double-throw hand switch; the automatic overload or return current relays operate by closing the motor circuit.

The first oil-break switch to be put into practical use was at the Paderno power station in 1897; this was designed by Messrs. Brown, Boveri & Co., for three-phase currents at 16,000 volts. The same firm makes a hand-operated switch, of which a large number are in use on the system of the Newcastle Electric Supply Co. There is one oil chamber for the three phases, but a wooden lining partitions the chamber into three. There are six fixed contacts and three copper bridging pieces, which are moved vertically to make or break circuit; underneath each pair of contacts is a small board, which moves up and down with the bridging-pieces and churns the oil at the moment of make or break, thus minimising the danger from carbonisation of the oil. The writer has tested this type of switch severely at 6,000 volts, and found it in every way satisfactory. A similar type of three-phase switch, also made by Messrs. Brown, Boveri, but for a higher voltage, is shown in fig. 6. The oil chambers are lowered down, showing a fourfold break on each pole. The design of the insulators is especially good. The switch is operated by hand.

Overload Relays.—These are usually worked by series transformers in each phase, the secondary current passing through a solenoid, which actuates the tripping device.

A representative device for obtaining a time-lag in operation is as follows:—

Fig. 7.—The secondary current of the series transformer passes round the windings of a magnet, between the poles of which is a copper disc capable of rotating; on the same spindle as this disc is a small drum to which a weight is connected by a fine cord. Normally the disc is stationary, the tendency to rotate being balanced by the moment of the weight; on an overload the disc rotates and winds up the weight, which closes an auxiliary circuit, and thus opens the main switch. The rate of rotation is proportional to the current flowing in the main circuit, and the time-lag may be adjusted by altering the length of the cord. Such an arrangement is very sensitive and works well.

Reverse Current Relays.—Such devices are actuated by the secondary current of a transformer, having two or more primary windings, one in series with a line, the other across two lines. Under normal conditions the fluxes produced by these windings are in opposition, that of the potential coil being the stronger, but when the power flows in the reverse direction, a current is generated in the secondary circuit which works the relay. Should a generator break down, in the majority of cases the current passing

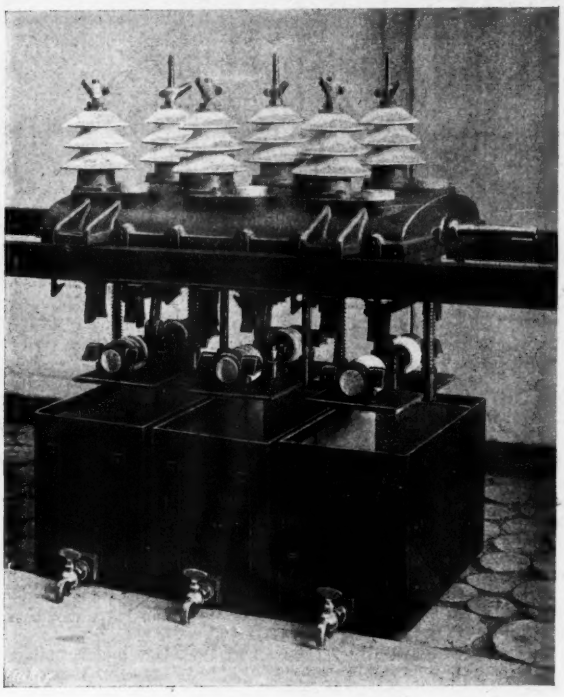


FIG. 6

will be the short circuit current of the machine (great enough to work an overload relay), but at the same time the pressure across the terminals of the alternator (and the transformer) may fall to zero, and the relay not act. For these reasons return current indicators find more favour than relays; the indicator, usually a coloured lamp, shows which part of the system is at fault, and the switch is operated by the attendant.

A very neat reverse current indicator is that of Mr. Andrews, described in his paper before the Institution of Electrical Engineers in March, 1903.

Devices which Prevent or Relieve Excessive Pressure Rise.—The causes of pressure rise in a system are set out above. Any device which only acts on the switching on or off of a cable is a partial safeguard which should not be used if a complete safeguard can be found. For such a purpose as the above series resistances (liquid) and choking coils have been used, and in many cases afterwards discarded.

Spark-gaps which remain always connected across the cores of each cable meet every rise of pressure from whatever cause, but

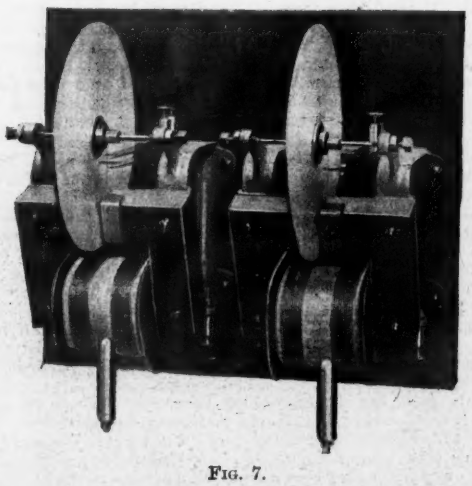


FIG. 7.

have disadvantages. The most sensitive spark-gap consists of needle-points in air, the disruptive voltage being almost independent of humidity and dust, but the passage of a small spark will destroy the points. The horn arrester, in which the arc is struck across the lower extremities and rises until it breaks, has found extensive use. The Wurts arrester has a number of brass

cylinders, with knurled or smooth surfaces, placed with their axes parallel, and with equal gaps between them. In this type the nature and mass of the metal chills the arc which may be formed. A modification of the above consists of two concentric cylinders, the ends of the outer cylinder having conical additions. The arc is chilled as in the Wurts, and blows itself out as in the Siemens type.

Series resistances are occasionally used with the idea of minimising the rush of line current which may follow a discharge.

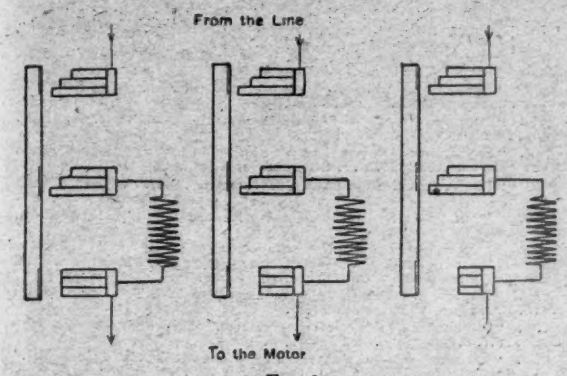


FIG. 8.

The writer has found the Wurts type to be fairly reliable; but when dealing with large rises of pressure and large powers, the discharge localises on the cylinders and forms blisters, sometimes fusing the rollers together.

In all the above an arc in air may form, with consequent danger to the system, and for this reason the writer has tried the effect of immersing spark gaps in oil. The disruptive strength of some mineral oils is about equal to that of air, so that the distance between the gaps need not be made smaller. The gaps are protected from dust and moisture, and the sparking distance remains constant. The arc is extinguished in the oil as in the oil-break switch, and it is reasonable to suppose that it is extinguished at the instant of zero current. On the disturbance of a system, due to a sudden change of current flowing, these gaps must be capable of absorbing a considerable amount of energy—the energy of the surge—and are therefore liberally proportioned.

To test the oil-immersed spark gaps the following experiment was made. The oil gaps were set to discharge at 8,000 volts on an inductive circuit, and shunted by a pair of needle points set to discharge at 10,000 volts. On the application of 8,000 volts the gaps worked, the arc being extinguished in the oil; the applied voltage was gradually raised to 10,000, but the oil gaps worked in every case, and the needle points never came into action. The test was then repeated with both sets of gaps in air, when the needle points sometimes acted before the horns.

Switching Inductive Apparatus.—On switching on a transformer or induction motor, the full pressure may momentarily exist between adjacent end coils with consequent breakdown; this abnormal stress may be minimised by switching on slowly through a resistance; as an example, fig. 8 shows the arrangement of a switch for use with a three-phase high-tension induction motor. The switch has three extra terminals connected to water resistances; on switching on, these resistances are first put in series with the windings of the motor, then short-circuited, and lastly, cut out. On switching off the reverse operation takes place.

CAST-IRON FOR PISTON RINGS.

By C. H. Wingfield.

(Abstract of Paper read before Section G.)

The laws controlling the elongation of steel or wrought-iron rods subjected to stress are not applicable to cast-iron without modification, as raw cast-iron has no initial elastic limit. However, when a stress is applied to cast-iron, it takes a permanent set, and so long as the original stress is not exceeded, the elongations thereafter are proportional to the stresses. The author points out the inaccuracy of the published formulæ relating to cast-iron piston rings, through the neglect of this phenomenon, and describes experiments made to determine the best proportions for cast-iron spring piston rings. The permanent set of rings of various diameters, after being pushed into a ring gauge 128 mm. in diameter for increasing periods, was ascertained, and from this the actual "follow" as compared with the intended "follow" was deduced. The maximum designed "follow" which did not cause fracture was ·4 in., while ·5 in. broke the ring (which was from 5·236 to 5·726 in. in diameter). After the permanent set has been given, the material appears to be perfectly elastic within the limit of the original stress; a cast-iron ring 5 in. in diameter, with its cut ends 1½ in. apart, can be bent until they touch, after which they will spring apart to 1½ in., and this can be repeated indefinitely without further permanent set being acquired. The results are embodied in tables and curve diagrams.

CELLULAR SWITCHGEAR FOR THE COLONIES.

The Ferranti cellular switchgear is becoming very popular in the Colonies for use in central stations, on both continuous and alternating current systems. Melbourne, Adelaide, Sydney, Bloemfontein, Durban and East London are all to be counted amongst the important places where the apparatus is, or will be, installed.

The makers, in considering the design, appear to have fully recognised the difficulty in procuring skilled labour for erecting in the Colonies, and have produced a type of their well-known designs

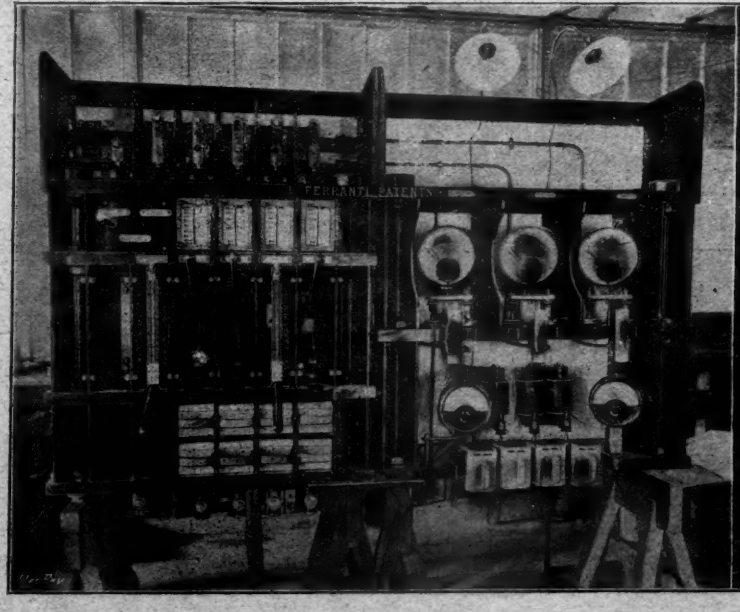


FIG. 1.

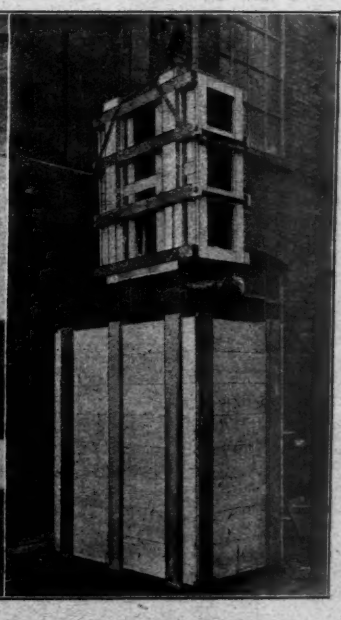


FIG. 2.

which can be very readily placed in position and connected up without requiring expert erection.

Fig. 1 is reproduced from a photograph taken of a switchgear just before packing for shipment to Pietermaritzburg, and fig. 2 shows very clearly the method of packing, which is of great importance for such work. It will be seen that the switchgear is made in complete self-contained sections, which are finished off in every detail at the makers' works. The sections are first surrounded by strong wooden battens clamped together by iron bolts, and then the

whole is let down into an external packing case; the space intervening between the two packing cases is filled in with material of a springy nature. On the arrival of the cases at their destination it is only necessary to lift the section with the internal packing from the case and rest it upon trestles or brick piers. Then only is the switchgear proper disclosed, and by the simple means of joining up the bus-bars with links provided for the purpose, the entire apparatus is made ready for service.

Great security is afforded by these designs, and we think the makers are fully justified in their claims that the cellular type of switchboard, while minimising fire and life risks, and combining simplicity of construction with economy in floor and wall space occupied, is of a remarkably self-contained and portable nature, no expert erection being required outside the makers' works.

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

19,711. "Improvements in rotary motors." E. Williams. September 14th.

19,714. "A terminal for sparking plugs." G. Roberts. September 14th.

19,715. "Improvements in electrolytic meters." S. H. Holden. September 14th.

19,748. "New or improved means for protecting the terminals of electric apparatus, and ensuring good electrical contact." W. Peto. September 14th. (Complete.)

19,780. "Improvements in or connected with electric lamps." G. Bamberg. September 14th.

19,792. "Improvements in or relating to regulating devices for motors and engines." F. Reichenbach. September 14th.

19,799. "Improvements in and connected with the production of electrotypes." S. Cowper-Coles & Co., Ltd. and S. Cowper-Coles. September 15th.

19,801. "An electro-chemically deposited jacket for explosion engines and the like." W. L. Baylay and W. A. Tritton. Dated September 15th.

19,877. "Improvements in electro-magnetic relay apparatus." Siemens Bros. & Co., Ltd. (Siemens & Halske, Actien-Gesellschaft.) September 15th. (Complete.)

19,882. "Improvements in electric fuses and the like." G. B. Baby. September 15th.

19,886. "Improvements in electromotive force regulators." B. G. Lamme. (Date applied for under Patents, Act, 1901, October 2nd, 1902, being date of application in United States.) September 15th. (Complete.)

19,887. "Improvements in controlling apparatus for electric motors." B. G. Lamme. (Date applied for under Patents, Act, 1901, September 29th, 1902, being date of application in United States.) September 15th. (Complete).

19,893. "Improvements in spark extinguishers for locomotives." J. W. Bryant. September 15th.

19,894. "Improvements in incandescent electric lamps." W. C. Robison. September 15th.

19,896. "Improvements relating to the driving of dynamos by steam turbines." W. E. Evans. (Gesellschaft zur Einfuhrung von Erfindungen, m.b.H., Germany.) September 15th. (Complete.)

19,927. "Improvements in the construction of switch-gears for electrical purposes." H. W. Clothier. September 16th.

19,948. "Improvements in alternating current induction motors." L. J. Hunt and the Sandycroft Foundry Co., Ltd. September 16th.

19,961. "An improvement in electric tumbler switches." Sir Hiram Maxim Electrical and Engineering Co., Ltd., and J. Harrington. September 16th.

19,965. "Improvements in and relating to electric lamps." W. C. Head, W. A. Snape, and R. C. Volland. September 16th.

19,974. "Improvements in electrical conducting trolley mechanism for electrical tramcars or the like vehicles." F. W. Massey and T. C. Perkins.

20,000. "Improved method of rectifying alternating electric currents." G. Bamberg. September 16th.

20,015. "An improved brush stock for revolving brushes driven by electricity." J. MacLean. September 17th.

20,017. "Improvements in field-magnet bobbins specially adapted for small dynamos and motors." J. MacLean. September 17th.

20,043. "Improvements in electric glow lamps." J. R. Crawford. September 17th.

20,047. "Improvements in means for automatically lighting electric railway carriages, tramcars, and other places by supplementary currents of electricity, in case of the accidental failure of the main current." J. R. Quain. September 17th.

20,061. "Improvements in receivers for wireless communication." G. Morin. September 17th. (Complete.)

20,072. "Improvements in coin mechanism especially applicable to electricity and other meters." E. Du Mois. September 17th.

20,100. "A rotary hair brush, having means whereby the hair and scalp can be electrified." J. MacLean. September 18th.

20,109. "Improvements in variable resistances." J. W. Hamm. September 18th.

20,128. "Improvements in or relating to electric lighting." B. G. Lamme. September 18th. (Date applied for under Patents Act, 1901, September 29th, 1902, being date of application in United States.) (Complete.)

20,155. "Improvements in electricity meters." P. Ribunier. September 18th. (Date applied for under Patents Act, 1901, October 2nd, 1902, being date of application in France.) (Complete.)

20,219. "Improvements in or relating to electric traction and apparatus therefor." W. S. Boult and C. R. Boult. September 19th.

20,230. "Improvements in automatic circuit breakers." E. P. Wetmore. September 19th. (Complete.)

PUBLISHED SPECIFICATIONS.

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1902.

5,972. "Improvements in electrical signalling apparatus for railways." E. Danneels. Dated March 11th.

8,172. "Improvements in and relating to apparatus for the production of electrical oscillations of requisite amplitude and frequency." H. Manders and A. W. Sharman. Dated April 8th.

10,141. "Improvements in or relating to electrically-operated switch locking and operating devices particularly applicable for railway and like purposes." F. Prochaska. Dated May 2nd.

10,181. "Improvements in syntonic space telegraphy." O. J. Lodge and A. Muirhead. Dated May 2nd.

10,262. "Improvements in and relating to arrangements for controlling automatic electric regulators, cell switches, and the like." W. E. Evands. (Allgemeine Electricitäts Gesellschaft.) Dated May 3rd.

12,697. "Improvements in perforators for use in connection with automatic telegraph transmitters." A. Muirhead. Dated June 3rd.

12,702. "Improvements in the electrical production of iron alloys with the simultaneous production of alkaline oxides and alkaline earths." G. Gin. Dated June 3rd.

12,767. "Improvements relating to the control of electric motors." H. H. Lake. (General Electric Co.) Dated June 4th.

12,783. "An improvement in electro-magnetic detents." Siemens Bros. and Co., Ltd., and A. Siemens. Dated June 4th.

12,958. "Improvements in switches and electro-motors." H. H. Lake. (General Electric Co.) Dated June 6th.

12,959. "Improvements in machines for winding insulating tape or the coils of electrical apparatus." H. H. Lake. (General Electric Co.) Dated June 6th.

13,491. "Intercommunication switch for telephones." H. R. Webb. Dated June 14th.

13,545. "Improvements in or connected with arc lamps." K. Weinert. Dated June 14th.

13,556. "Improvements in means for the control of the supply of electricity to electric motors for hauling plant and similar apparatus in which the demand for energy is intermittent." C. Ilgner. Dated June 14th.

13,732. "Improvements in electric arc lamps." British Thomson-Houston Co. (C. E. Harthan.) Dated June 17th.

13,734. "Improvements in electric transformers." British Thomson-Houston Co. Ltd. (W. S. Moody.) Dated June 17th.

13,739. "Improvements in and relating to electric insulating material." H. H. Lake. (General Electric Co.) Dated June 17th.

13,982. "Improvements in electric signalling apparatus for use on and in connection with railway locomotive engines and the like." H. J. Bounevialle and A. C. Bounevialle. Dated June 19th.

14,270. "Improvements in dynamo-electric generators." E. W. Smith. Dated June 24th.

14,487. "Improvements in electrical automatic cut-outs." E. W. Cowan and W. B. Dale. Dated June 30th.

14,667. "Improvements in electricity meters." E. Schattner. Dated July 1st.

14,829. "Improvements in detectors of electric currents induced in systems of space telegraphy." E. Wilson. Dated July 3rd.

14,884. "Improvements in electric distribution systems." H. H. Lake (General Electric Co.) Dated July 4th.

14,901. "Improvements in or connected with the brakes of electric and other tram cars and vehicles." G. Atherton. Dated July 4th.

15,039. Improvements in methods and means for connecting multiphase electric circuits." British Thomson-Houston Co., Ltd. (W. S. Moody.)

15,226. "Improved means for electrically controlling mechanical motion." A. P. S. Macquisten. Dated July 8th.

15,324. "An improved device for enabling low tension lamps of high amperage to be employed on electrical distributing circuits of any voltage." J. Klopfenstein. Dated July 9th.

15,347. "Improvements relating to arc lamps." H. H. Lake. (General Electric Co.) Dated July 9th.

15,413. "Improvements in electric lamps." W. J. Davy. Dated July 10th.

15,458. "Improved means of mounting and carrying the brushes of electrical switches, dynamos, motors, and the like." A. H. Hickley. Dated July 11th.

15,591. "An improvement in electric stoves." H. J. Dowsing. Dated July 12th.

15,747. "Improvements in or relating to electric storage batteries." M. Sutherland and E. Marcuson. Dated July 15th.

15,807. "Improvements in or relating to electric accumulators." C. de Sedneff. Dated July 15th.

15,813. "Improvements in life-saving or accident preventing devices, chiefly applicable for electric tramcars." E. Bunting and Wilson & Bennett, Ltd. Dated July 16th.

15,815. "Improvements in or relating to electric fuseboxes for street mains and analogous uses." The Electric and Ordnance Accessories Co., Ltd., and R. F. Hall. Dated July 16th.

15,828. "Improvements in or connected with electrical fuse boxes or cut-outs." G. H. Nisbett. Dated July 16th.

15,825. "Improvements in electric rail bonds." G. H. Nisbett. Dated July 16th.

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16,048. "Improvements in dynamo-electric machinery." H. Leitner and R. N. Lucas. Dated July 18th.

16,062. "Improvements in and connected with third rail conductors and their guards on electric railways." H. H. Lake. (General Electric Co.) Dated July 18th.

16,063. "Improvements in and relating to third-rail contact-shoes for electric railways." H. H. Lake. (General Electric Co.) Dated July 18th.

16,064. "Improvements in and connected with third rail conductors and their guards on electric railways." H. H. Lake. (General Electric Co.) Dated July 18th.

16,142. "Apparatus for indicating that an electric current has reached a predetermined amount, and for the consequent closing of a switch or switches." J. Edmondson, W. A. Purdom, J. W. Dawson and Edmondson & Purdom, Ltd. Dated July 21st.

16,178. "Improved means for applying and removing electric incandescent lamps." J. W. Kirk. Dated July 21st.

16,858. "Improvements in electrolytic processes in apparatus therefor." L. Gurwitsch. Dated July 23rd.

16,991. "Improvements in and relating to electric incandescent lamps and to circuits and conductors therefor, for decorative and other purposes." G. Weissmann. Dated July 23rd.

16,824. "Improvements in apparatus for use in electro-plating." A. J. A. C Marichal. Dated July 29th.

16,925. "Improvements relating to the control of electric motors." H. H. Lake. (General Electric Co.) Dated July 30th.

16,928. "Improvements in counters or tell-tales for electric circuit-breakers or current-indicators. H. H. Lake. (General Electric Co.) Dated July 30th.

16,989. "Improvements in electric cables." W. T. Henley's Telegraph Works Co., Ltd. and H. Savage. Dated July 31st.

17,106. "Improvements in and relating to overhead trolley lines or conductors and the like." H. S. Cowx. Dated August 2nd.

17,134. "Improvements in holders for incandescent electric lamps." L. H. Newton and R. R. Neville. Dated August 2nd.

17,141. "Improvements in automatic electrical switches." A. S. Adler. Dated August 2nd.

18,516. "Improvements in electric circuit breakers." The British-Thomson Houston Co., Ltd. (J. P. Wood.) Dated August 20th.